January, 1978
Price, $2.00

Frank Press on New Priorities
Lester Thurow on R & D
Randi on Seeing Is Not Being

More on Innovation:
The User's Role in New Products

# Technology Review

Edited at the Massachusetts Institute of Technology

## Energy Conservation: Beyond the Quick Fix

technology
review
Published by MIT

# "It's 52° below zero up here, but, crazy as it sounds, we need this machine to keep the ground frozen."

"When you drill for gas north of the Arctic Circle, the way we're doing here at Canada's Mackenzie Delta, you expect a lot of problems," says Bob Toole, drilling superintendent for Gulf.

"But this one's a real fooler. It's a freezing unit. Even at 52° below zero, we need it to keep the ground around the wellhead frozen.

## Hot mud

"The problem is that when the drilling mud comes up from the bottom of the hole, maybe a mile down, it's hot enough to melt the permafrost that's holding up the whole rig.

"If the permafrost melted, the hole would get bigger and bigger, and the operation would have to come to a halt.

## Frozen pipes

"Our freezer keeps the top thirty feet of the casing around the drill pipe at temperatures below freezing, so that doesn't happen.

"This country is probably one of the toughest spots on earth to drill for natural gas. But we're drilling the wells. We're meeting the challenge."

Gulf

**Gulf people: meeting the challenge.**

"At temperatures as low as this, you have to invent new ways to do almost everything."


Left to right: Bob Toole, roustabout Jacob Kuhoktak, and the freezer.

Gulf Oil Corporation

# Jim Mitchell helps make glass ultra-transparent ...

so that hair-thin glass fibers can carry telephone calls as pulses of light in lightwave communications systems.

In this new technology, transparency of the glass fibers is a critical factor in their ability to carry light signals for communications. And thanks, in part, to advances in materials analysis achieved by Jim Mitchell and his colleagues, Bell Labs and Western Electric are producing some of the most transparent glass the world has ever known.

Jim led a task force that identified and measured extremely small amounts of impurities in raw materials used to make glass fibers. With a BS in chemistry from North Carolina A&T, and a PhD in analytical chemistry from Iowa State, he was well prepared for the job.

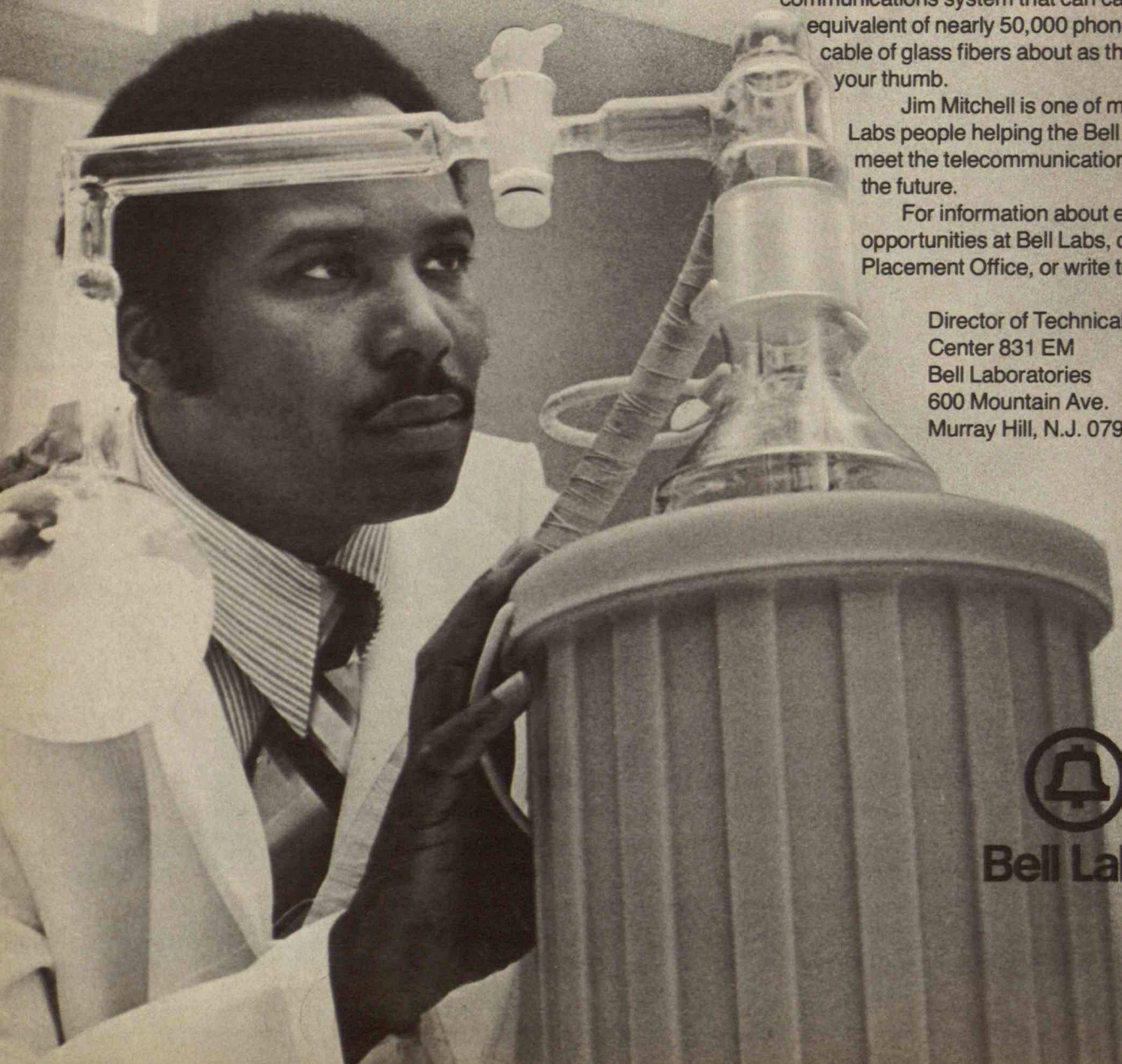
Since contamination could easily be caused by lab equipment and even the air in the room, Jim first designed a special "clean room" for the research and then devised highly sensitive analytical methods for measuring impurities as low as two parts per billion. One of his techniques, cryogenic sublimation, is a promising low temperature process for purifying chemical reagents.

Jim's contribution to basic knowledge about the measurement of low-level impurities was essential for development of today's sophisticated fiber-making procedures. As a result of this and other advances, Bell Labs and Western Electric are now working on an experimental lightwave communications system that can carry the equivalent of nearly 50,000 phone calls in a cable of glass fibers about as thick as your thumb.

Jim Mitchell is one of many Bell Labs people helping the Bell System meet the telecommunications needs of the future.

For information about employment opportunities at Bell Labs, contact your Placement Office, or write to:

Director of Technical Employment
Center 831 EM
Bell Laboratories
600 Mountain Ave.
Murray Hill, N.J. 07974



Bell Labs

Edited at the Massachusetts Institute of Technology

Volume 80, Number 3
January, 1978

# Technology Review

*Technology Review,* Reg. U.S. Patent Office, is published eight times each year (in October/November, December, January, February, March/April, May, June and July/August) at the Massachusetts Institute of Technology: three special editions are provided for graduate (pp. A1-A24) and undergraduate (pp. A1-A24 and B1-B16) alumni of M.I.T.  Technology Review is printed by The Lane Press, Inc., Burlington, Vt. Second class postage paid at Boston, Mass., and at additional mailing offices.

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: Technology Review, Room 10-140, Massachusetts Institute of Technology, Cambridge, Mass., 02139. Telephone area code (617) 253-8250. Unsolicited manuscripts are welcome, but no responsibility for safekeeping can be assumed.

Price: $2 per copy. Subscriptions: in the U.S., Canada, and Mexico — $15 one year, $24 two years, $32 three years; overseas $23 one year, $38 two years, $50 three years. Please allow three weeks for changes of address and give both old and new addresses in all requests.

*Technology Review* advertising is represented by The Leadership Network: Robert Sennott, Suite 321, 230 Park Ave., New York, N.Y. 10017 (212) 682-4500; Larry Benson, The Benson Co., 200 East Ontario St., Chicago, Ill. 60611 (312) 787-4477; James L. Latta, Jr., 1400 North Harbor Blvd., Fullerton, Calif. 92635 (714) 879-8930; Beth Newburger, *The New Republic,* 1220 19th St. NW, Washington, D. C. 20036 (202) 331-9787. Also by William T. Anderson, Littell, Murray, Barnhill, 60 East 42nd St., New York, N.Y. 10017 (212) 867-3660

Technology Review is a member of the Audit Bureau of Circulation

*Publisher*
James A. Champy

*Board of Editors*
John I. Mattill *(Editor)*, Sara Jane Neustadtl, Michael Feirtag, Leonard A. Phillips, Marjorie Lyon, Deborah McGill, Susanne Fairclough

*Production*
Kathleen B. Sayre

*Advertising*
Richard F. Wright

*Circulation*
Evelyn R. Milardo

*Subscription Service*
Dorothy R. Finnerty

*Permissions and Reprints*
Sandra Knight

## Articles



## Departments

# Passages: Work and Aging in America

*Kenneth E. Boulding is a director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to* Technology Review.

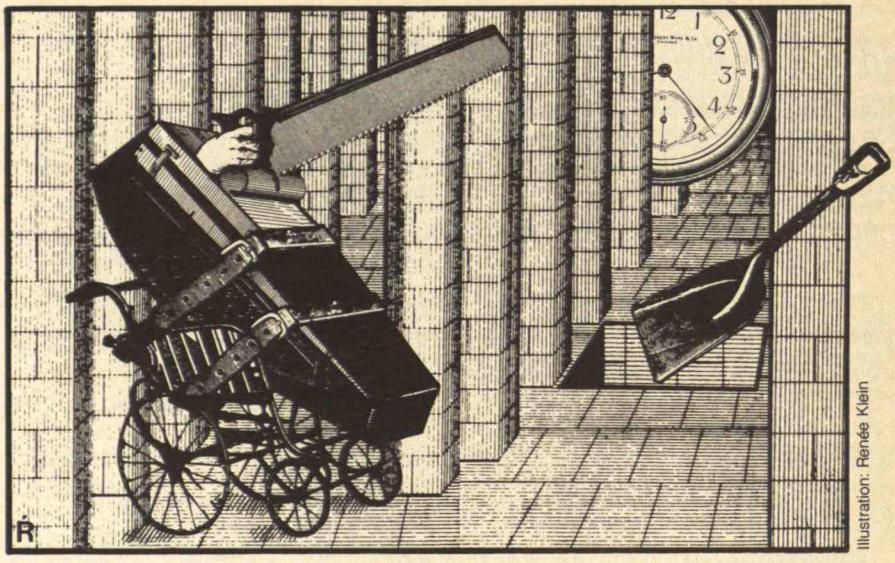


Illustration: Renée Klein

Congress has provoked national debate about "age-ism," mandatory retirement, Social Security, and pensions. I cannot claim to view the problem from the Olympian heights of youth or even middle life. I will be 68 this month, and in my university it has been the law of the Medes and Persians that this means "out": one becomes a Professor Emeritus with all the rights and privileges attached. As far as I know, they consist mainly of cheap football tickets and maybe a desk somewhere. So I am fortunate that the Institute of Behavioral Science with which I am affiliated has somewhat more liberal provisions.

People clearly age at different rates, and on this score I seem to be among the blessed. I can manage a ten-mile hike in the mountains, and in my recent physical examination I think my doctor was almost disappointed to find so little amiss. Consequently, my reflections on what I shall call "active later life" are colored by private interest.

### Active Later Life

After the rather unfortunate period called "youth" — a disease which has the great gift of being curable — life seems to take three main stages. First comes middle life, which is marked by a certain stability: for instance, tenure in academic circles, seniority in trade union circles. This is the time of child rearing, buying a house, professional advancement, and very often, rising income.

Middle life is succeeded for an increasing number of people by active later life. We may be just as active as in middle life, and even more mature and wise. Productivity may increase. But our notion of time is different and responsibilities tend to be different, as well. Children are off on their own, and we do not have to worry about our career. There are funerals among our contemporaries, and we realize that we are not going to live forever, even if we can expect to hang on for quite a long time in good health. For some people this is the happiest, most productive and creative period of life. If we are lucky, it may be terminated suddenly and unexpectedly. Or this period may deteriorate to inactive later life, and true retirement.

We have fairly adequate institutions to provide for middle life and for inactive later life: jobs, homes, and families; nursing homes and hospitals. But we have no adequate institutions for active later life. Yet this period is likely to become much more important as health care improves, the aging process is slowed, and the proportion of people achieving this condition increases.

Institutions to accommodate this period are only now beginning to appear. Some corporations, for instance, have set up consulting firms for their active retired executives and a few universities have not set a mandatory retirement age. But for the most part, administrators cling to mandatory retirement like a great air bag which saves them from difficult and painful decisions. A cardinal principle of administrative behavior is the minimization of trouble. Nevertheless, administrators are paid both to take trouble and to be in trouble. Society is therefore amply justified to impose trouble on them.

### Liberation by Contract

The institutions we devise for active later life should emphasize the ingenuity and freedom of contractual relations. Short-term contracts with options of renewal at the will of both parties ought to predominate. There should also be some machinery for collective decision to resolve the problems of transition into inactive later life which will inevitably arise.

Universities are singularly insensitive to the need for organizational and institutional change. Mandatory retirement at a fixed age cannot be sustained indefinitely now that the ethic of anti-discrimination is so strong. Age-ism (like racism and sexism) is paradoxically a failure to use discretion. We treat different cases as if a single criterion made them alike, and thus we violate the fundamental principle of equity on which all legal arrangements should be based. Discretion is more difficult than discrimination; this is one reason why discrimination has been popular. But the fact that it is popular is no excuse for it. The compulsory extension of mandatory retirement to congressionally defined ages is an inadequate answer to the problem of age discrimination, for it simply denies that a problem exists.

For the universities my solution is to set up Institutes of Senior Scholars, with two-year contracts renewable at the will of the parties and open for general competition and negotiation. Income and salary are here less important than conditions of work. Senior scholars need a "set-up": perhaps just an office and secretarial help, perhaps a full-time secretary and a couple of research assistants, perhaps even a laboratory with a fairly elaborate program. Tentative contracts should be proposed both by scholars and by the institutes, and neither side should hesitate to propose modifications.

I certainly do not wish to replace all status with contract. I might argue that

*Continued on p. 28*

# Heating Up in Anaheim

*David F. Salisbury, who reports on science for the* Christian Science Monitor *from its West Coast Bureau, is a regular contributor to the* Review. *He studied physics at the University of Washington (B.S. 1969).*

At the Los Angeles Energy Fair, held in the unabashedly space-age contours of the Anaheim Convention Center within sight of Disneyland, there was a sense of futures present. The outline of a rapidly approaching era — now called the post-petroleum age for want of a better name — glimmered among the various booths and displays but resisted sharp definition.

Within the well ordered world of Disney, Tomorrowland and Fantasyland are neatly divided. At the Energy Fair, however, fantasy and reality jostled elbow to elbow. Entrepreneurism and energy have created a plethora of gadgets ranging from the ridiculous to the sublime.

### Pitches and Decolleté

Caveat emptor is the rule of the game. At one booth, a pitchman with brilliantine hair is in the midst of his spiel. An elderly couple — she with blonde, bouffant hair, he with a gray crewcut — listen earnestly. "We have faith in this product," the salesman is saying. A cutaway of the "infra-molecular heater" reveals that the galvanized box contains nothing more than a small fan and four floodlights which shine on a black metal sheet, to which a number of needles have been soldered.

Nearby several colleges have booths. Each offers energy courses. Coastline Community College, for instance, has recently started four classes, says Wayne Crawford, who is manning the booth. Most of those enrolling are professionals who already have some acquaintance with energy issues. There is little interest among high school students, Mr. Crawford reports.

Further on, the fair-goer encounters another energy novelty: "thermic art." The clue that the paintings displayed are not just inept reproductions of Remingtons is the electric cord dangling from each picture. Thermic art, one of its promoters claims, is "an effective and decorative way to heat your house." It is three times as efficient as electric resistance heat at the ceiling, he says quickly. Asked how thermic art compares with electric baseboard heaters, he replies that the floor is a bad place for heaters because they do not respond quickly to the thermostat. It is not clear just how thermic art compares with regular electric resistance heat — which is generally the most expensive and least efficient form of space heating. One can only hope that the invention is more efficient than it appears.

In another display, a bulky, black instrument vaguely resembling an antique camera makes energy visible. Color pictures show heat leaking out around windows and doors, through two-by-four studs in the walls. The warmth of a person's hand gives the machine an intriguing aura. Although legitimate, the device recalls an episode of *All in the Family*. A quick-talking con artist sells Archie Bunker a load of worthless siding. His main prop is a light meter which measures heat loss, or so he convinces Archie.

Next to the F.H.A.- and H.U.D.-approved plywood dome ("beat the high cost of housing and save energy too"), a beautiful brunette wearing an earth-colored decolleté dress stands before an illustration of an industrial heat recuperator. Everywhere slick chrome and black displays of aerospace and oil corporations war with hand-lettered signs and mimeographed proclamations of self-appointed energy prophets.

### Upper-Class Chic

Most numerous among the displays are solar heaters in a variety of shapes, sizes, and designs. They range from the expensive, high-performance, high-technology products of companies such as Grumman to bent sheet-metal and fiberglas contraptions apparently made in someone's garage.

Also prevalent are swimming-pool heaters. For example, the "pool blanket" is a transparent sheet of plastic bubbles which, when spread over a pool, retains the heat generated by sunlight. Another product is a plastic lens about the size of a hula hoop. Finally there are full-fledged flat-plate collectors to be installed on the roof for domestic hot water.

Outside, a small wind generator of conventional design provides the electricity for guitarist Bruce Lofgren's daily concerts. During his performances, the vibrant sound of his picking is not only blowing in the wind but also amplified by its energy.

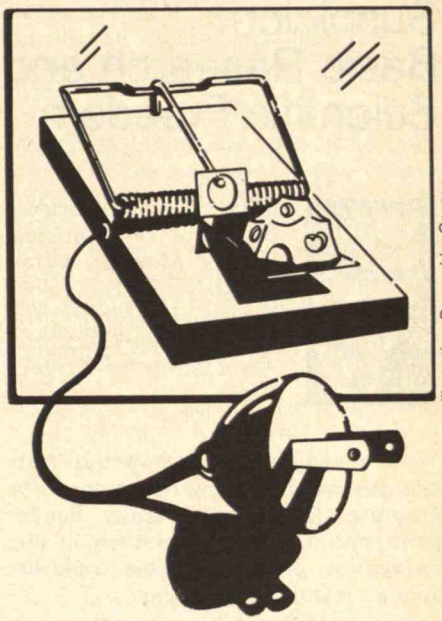


Illustration: Bernard La Casse

A short distance away, the Jet Propulsion Laboratory has set up a ham radio station. Next to a table equipped with transceiver and operator is a bank of solar cells. With only the power of the California sun, the operator has contacted stations in Japan, British Columbia, and a number of states in the U.S.

Here, too, children ride on a solar-powered carousel. Novelties of this sort are necessary to capture people's interest and attention, says the fair's organizer, Shirley Solomon. For this reason, she has enlisted the aid of a number of Hollywood celebrities. "People who don't pay any attention to what they read in newspapers will listen to somebody like Jack Lemmon or Paul Newman," she says.

The crowd appears to be almost entirely middle- and upper-class. Energy conservation is catching on as upper-class chic. Before the emerging ethic can have significant impact it must develop a much broader base of support. Meanwhile, on the Santa Ann freeway two blocks away, heavy traffic speeds at 65 m.p.h. □

# Suspicion: Basic Research and Scientific Freedom

*Robert C. Cowen, Science Editor of the* Christian Science Monitor, *writes regularly for* Technology Review. *He is former president of the National Association of Science Writers.*

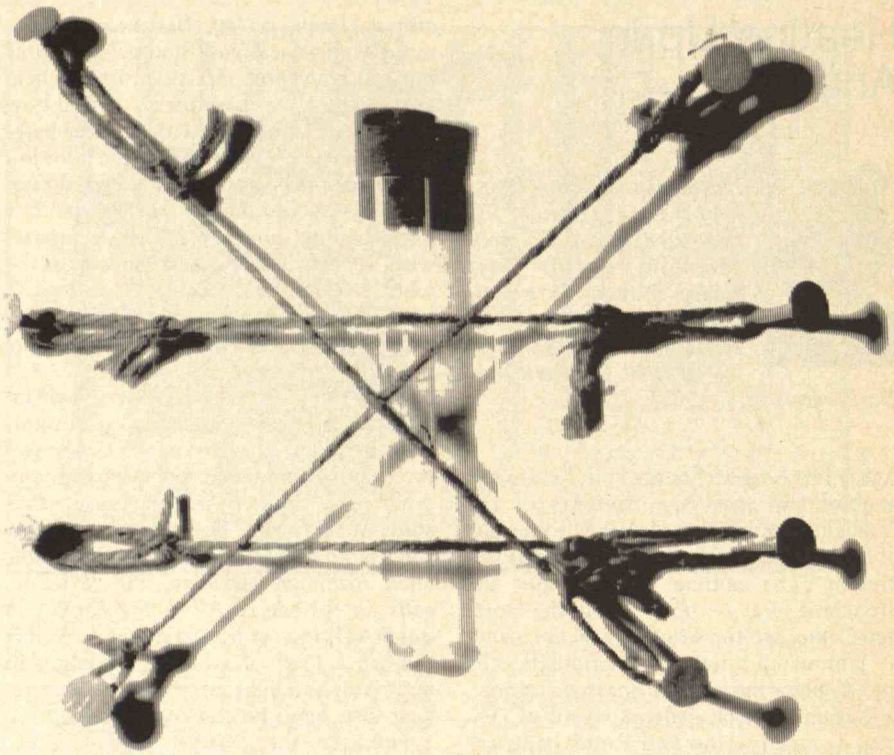


Illustration: Judy Richland

When Sputnik went up just over 20 years ago, it seemed to many Americans to be an omen of Russian superiority. But for hard-pressed American scientists, it was an angel of deliverance. They could use another rescuing angel today.

In 1957, support for basic research in the U.S. had reached a nadir. Some government agencies literally ran out of money to pay for projects for which they had issued firm contracts — a situation Sputnik helped correct. American research and development is hardly starving today. Yet on the whole, research and development here has reached a plateau. Support for basic science is uneven, and faltering in such areas as high energy physics or astronomy. A faddish anti-intellectualism gnaws at the integrity of the scientific enterprise.

This is why James R. Killian, Jr., in his memoir *Sputnik, Scientists, and Eisenhower (M.I.T. Press, 1977; see December, pp. 9-12, for an excerpt and review),* judges a crisis of confidence in American science to be as much the most important science-related policy issue facing the President, now as in 1957. Then the crisis was brought on by over-reaction to a foreign challenge. Today, the lack of confidence stems from failure of vision at home, from fear of misuse of science and technology, and from uncertain social responsibilities. In each case what was and is at stake is the health of basic science and technical innovation — the ultimate strength of American technology.

### The Shock of Sputnik

America entered the Sputnik era with a cocky arrogance concerning its technological prowess. The Russians were considered slide-rule mechanics — no match for American sophistication. Sputnik punctured that silly notion. In the panic that followed, many Americans swung to the equally foolish extreme of thinking that, technologically, they couldn't do anything right. To calm the nation and deal with the complex issues he faced, President Eisenhower appointed Dr. Killian the first Special Assistant to the President for Science and Technology.

In his memoir, Dr. Killian summarizes the true state of American science and technology at that time: "The Russians were able in the 1950s, and are able today, to meet any single challenge the American economy can offer. But they have not, in the field of technology, proved capable of meeting *all* the challenges the American economy can offer. They managed in the 1940s and 1950s to build a nuclear capacity and a missile capacity. The United States managed in the same period to build those two capacities and at the same time to provide an enormous range of consumer goods, a submarine nuclear striking force, an aircraft industry that provided most of the world's transport planes, an enormously advanced computer technology, an extraordinary broad-band communications facility, plastics and synthetic fibers, a rapidly advancing medical technology, and a host of other achievements.

The power of American technology is not that the United States landed men on the moon in a single decade but that we had the world's most advanced computer industry, the most advanced agricultural technology and productivity, and the most sophisticated and pervasive communications. At the same time American scientists had achieved world leadership in basic science."

Because of World War II and a flagging European vision, scientific leadership had passed decisively to the U.S. Yet when Dr. Killian took office, support for basic science was lagging. Research had become too expensive for universities to carry on without federal aid. At that time, the National Science Foundation had not yet become their mainstay. Much of basic science was still supported by the Department of Defense, which had come to the rescue of basic science in post-war years in default of any other source of funds. Its support was then cut back, suddenly and drastically.

For example, a few days after Sputnik went into orbit, I was summoned by high officials of the Air Force Cambridge Research Laboratories who, behind closed doors, leaked the embarrassing secret that the Air Force was about to default on its research contracts. Since A.F.C.R.L. was the main support of geophysics in America, the situation was serious. Yet it was typical of other areas of research at that time.

Thanks to the shock of Sputnik, Dr.

Killian and the President's Science Advisory Committee had no trouble with either Congress or the Bureau of the Budget in securing abundant support for basic research. But as Dr. Killian warns in his memoir, the fundamental lesson is the ease with which scientific leadership can slip from America's grasp if support for and appreciation of basic science falters.

**A Sagging Enterprise**

According to preliminary estimates of the National Science Foundation (N.S.F.), the U.S. spent some $40.8 billion in public and private funds for research and development in 1977. That's up 9 per cent from the $37.3 billion spent in 1976, or, in constant dollars, a "real" increase of 3 per cent. The federal government's share was some $21.8 billion. Development accounted for $26.6 billion, applied research for $9 billion, and basic research for $5.2 billion. The rise in research spending is expected to continue in 1978.

These figures inspire complacency. But last summer an N.S.F. report warned that the limited growth of basic research support in constant dollars threatens the health of American science. The average annual growth rate of 11 per cent in the mid-1960s dropped to about 1 per cent from 1968 through 1975. This, coupled with declining college enrollments, means an inadequate pool of scientific talent is being educated and exploited.

Bruce Smith of Columbia University and Joseph Karlesky of Franklin and Marshall College, the report's primary authors, explain: "We're not saying that we want to return to the boom days when science was being built up. But we think there should be a modest level of replacement of aging equipment and of new buildings. We're calling for revitalization of a somewhat sagging enterprise." They add more somberly: "The . . . adverse trends all seem to reinforce each other and point . . . towards a less speculative science, taking fewer chances, sticking with established lines of investigation. . . . By no means have these become the norm among university scientists or program officials, but the trends appear to point in those directions: unless they are checked, the consequences for American science could be serious."

Industrial observers are concerned that technology is also showing loss of vigor. *Industry Week* magazine warned last September that "money spent for research and development is not keeping up with inflation. In non-inflated dollars, it has actually dropped 5 per cent from its 1968 peak." W. Bowman Cutter of the Office of Management and Budget and William D. Nordhaus of the Council of Economic Advisors have called attention to a drop in federal basic research support of 22 per cent between 1970 and 1976. They pair this with a decline in productivity growth for the economy as a whole from an annual rate of 3.5 per cent in 1948-55 to a rate of 1.9 per cent during 1965-76. Although they admit there is no clear cause-and-effect dynamic working here, the parallel trends are suggestive. And to quote one more industrial prophet, Thomas A. Vanderslice, head of General Electric's Special Systems and Products Group, warns of a "decade-long decline in support of U.S. technology."

**Doubting Thomases**

Funding is not the only debilitating influence. Excessive caution, overregulation, and anti-intellectualism also undermine our technological enterprise. "Legislation and regulations dampen industry's ability to innovate," laments *Industry Week*. "I . . . see grave danger in overzealous efforts to seek a risk-free society and to impose limits on basic science and other forms of intellectual inquiry in a futile effort to achieve freedom from risks," says Dr. Killian.

Dr. Killian cites efforts to regulate research on recombinant DNA as an example. "The trend toward excess government regulation of universities has been particularly disheartening," he says. ". . . I see grave danger in the way some of our universities have been battered by an array of uncoordinated bureaucracies, each armed with admirable goals but collectively unmindful that the essence of a university is freedom."

Suspicion of scientific and technological activities comes not just from the public but also from within the ranks of science itself. That is why it is so dangerous. Many "concerned" scientists see social threat in the misuse of science that seems to take precedence over academic freedom. Uncontrolled recombinant DNA research is one such area. Research on the

*Continued on p. 28*

Dennis L. Meredith

Bryan Allen, pilot and champion bicyclist, pedals the *Gossamer Condor* to win the $86,000 Kremer Prize for the first successful man-powered flight. The *Condor* was built by a team headed by Paul MacCready. (Photo: Chester A. Kyle)

# Brain-Powered Flight

*Dennis Meredith is Director of the News Office for the California Institute of Technology. He was for three years Managing Editor of* Technology Review, *and is author of* Search at the Loch Ness *(New York Times/Quadrangle, 1977).*

It was the damnedest sight. Shimmering above the California desert, carried aloft on a huge wing and an even bigger prayer, was the *Gossamer Condor,* about as unlikely a flying machine as ever cleaved air. Floating forward at just over ten miles per hour, occasionally dipping perilously close to the airport runway, it seemed to have absolutely no physical business flying, much less trying to capture an 18-year-old prize for man-powered flight.

Even more unlikely than the 96-ft., Mylar-plastic-wrapped wing braced by piano wire and thin aluminum tubing was the propulsive force — a tall, skinny farm boy, leaning langorously back and pumping the plane's pedals almost absent-mindedly. He reclined in a plastic-wrapped cockpit, and behind him pushing the plane along its lazy course was a big, red, chain-driven propeller, flop-flopping at a couple of revolutions per second. Mounted in front of the craft was a small control stabilizer, which seemed to feel the air ahead of the *Condor* like a seeing-eye wing.

After a 6½-minute flight, the plane climbed slowly over a 10-foot-high barrier and the course was complete.

"We've done it!" shouted the pilot, as the scattered observers leaped and whooped. The £50,000 ($86,000) Kremer Prize for the first successful man-powered flight was won; the feat would embarrass some engineers and teach a great many more some good lessons about how to build successful machines.

### Alice-in-Wonderland Contraptions

The achievement last August 23 was an unmitigated triumph. Henry Kremer, the British industrialist, physical fitness buff, and aviation enthusiast who offered the prize in 1959, had challenged some of his sneakiest friends to subvert the rules. So the fiendishly clever requirements set down for the Kremer Prize left no loopholes in their definition of a successful man-powered flight.

The stipulations for the prize, established under the auspices of the Royal Aeronautical Society, required flying a figure-eight course around two pylons a half-mile apart. The start and finish lines came midway between the two pylons and had to be crossed at a minimum height of

10 ft. The winning flight had to take place in still air; no lighter-than-air gases or stored energy devices could be used in the plane; no power or control assistance could be given during take-off or flight. Further, no part of the craft could be jettisoned after take-off. The rules gave no quarter: only an exquisitely designed machine and a strong and able pilot in full control of his craft would be able to satisfy them.

So rigorous were the rules that malcontents, by now certainly embarassed, carped that they were unachievable, and that they should perhaps be eased to encourage man-powered aircraft development at a more realistic pace.

Dozens of entrants worked toward the prize, ranging from serious professional groups which spent years on their projects to slapstick-engineers fiddling together Alice-in-Wonderland contraptions in their garages. By 1976, several serious entrants had gotten off the ground, with the longest flight (about 2,000 meters) made by a Japanese craft with 12 years of development time behind it. But there seemed little danger that Henry Kremer would soon have to fork up.

Paul MacCready, head of the team which designed the *Gossamer Condor,* had little interest in man-powered flight before he began the project, and even less interest in a multi-year project consuming thousands of man-hours of painstaking construction work.

In July, 1976, he was interested only in a quick and dirty scheme to capture the prize. He was "droning along in the car" on a family vacation trip, "a sort of relaxed but boring situation which does tend to put one's mind in another state of consciousness, so some thoughts began chasing around. . . ."

Dr. MacCready was no stranger to the air — president of his own aeronautical engineering company, a championship glider pilot, and holder of a Ph.D. from the California Institute of Technology — so his reveries were educated ones.

"I had just done some calculations on how much horsepower a hang glider uses as it flies, and a good one is down around 1.2 horsepower, or even down to one horsepower," said Dr. MacCready. "I was working on an article on the performance of soaring birds such as hawks, and comparing that with hang gliders, and I was vaguely aware of the man-powered airplane contest. All of a sudden I kind of put a few things together and said if you just extrapolate hang glider technology and make a glider that's three times as big in all dimensions but doesn't weigh any more, its sinking speed will be only a third as much. Suddenly you have a vehicle that's consuming only one-third horsepower to fly, and man can put out more like a half a horsepower. . . ."

| Aircraft | Origin | Crew | Wing-span (meters) | Wing area (sq. meters) | Weight empty (pounds) | Weight loaded (pounds) | Cruise speed (meters/sec.) |
|---|---|---|---|---|---|---|---|
| BURD | M.I.T. | 2 | 18.9 | 59.4 | 105 | 390 | 7.9 |
| Olympian | Joseph Zinno (Rhode Island) | 1 | 23.8 | 29.0 | 147 | 284 | 9.0 |
| Bliesner | Wayne Bliesner (University of Washington) | 1 | 22.56 | 83.65 | 216 | 363 | 5.8 |
| Gossamer Condor | Paul B. MacCready *et al,* (So. California) | 1 | 29.0 | 93.0 | 69 | 207 | 3.6 |

Less than a month before the successful flight of "Gossamer Condor," John H. McMasters of Boeing and George M. Palmer of Purdue University published in *Astronautics and Aeronautics* this table of principal U.S. entries in the Kremer Competition for man-powered flight. The M.I.T. BURD — Messrs. McMasters and Palmer called it "the first really promising U.S. man-powered aircraft" — was the only bi-plane entry; the first version was damaged during a flight attempt in 1975, and a rebuilt aircraft was being tested as fickle New England weather permitted in 1977. The "Olympian" made a few very short flights before crashing after a towed flight in 1976. Wayne Bliesner's plane was destroyed when its hangar collapsed on it in the same year.

Dr. MacCready knew that one crucial equation relating horsepower requirements to design would unequivocally dictate the parameters of the *Gossamer Condor*. The equation holds that an airplane's horsepower requirements increase sharply with the weight, and drop as the wing area increases. Slow speed minimizes drag on the airplane. Once the numbers tumbled out — 96 ft. wingspan, 70-pound weight, 10 mile-an-hour speed — the *Condor* "just about designed itself," said Dr. MacCready. But not quite. Dr. MacCready gathered about him expert aerodynamicists from his company, hot-shot hang-glider pilots, and some ingenious plane-builders and tinkerers. They set to work with a vengeance.

The severe weight limitation meant that there could be little internal structure to the enormous wing. Whereas other man-powered airplanes boasted intricately engineered ribs about every 6 in. to both support and shape the wing, the *Condor* had ribs only every 6 ft. — spaced just closely enough to maintain the proper aerodynamic form. The leading edge was cardboard, "the kind you find in candy boxes," said Dr. MacCready.

This diaphanous wing and its human cargo were supported by piano wire strung from aluminum-tubing braces running the length of the wing and jutting out above, below, to the front, and to the rear of the plane.

### Art Over Science

"In essence, the *Condor* structure was six sticks and 72 piano wires connecting everything to everything else," said Dr. MacCready. The slow speed of the plane meant both that the profusion of support wires extracted little drag penalty and that the whole support structure could safely be quite flimsy. And even if the whole structure collapsed in midair, the 6 ft. or so fall to the ground would injure little more than a downed pilot's ego.

The solutions to all sorts of design problems fell simply into place. Since there was a support tube jutting down beneath the plane at midwing, the pilot and his pedals could be conveniently installed there. True, he would have to pedal leaning back, but a physiologist consulted by Dr. MacCready advised that this position makes little difference in the pilot's pedalling force. In fact, the pilot can control the plane better in this posture than with his head hunched forward in the traditional bicycling stance.

With the addition of a stabilizer jutting out front — placed there because a

*Continued on p. 28*

# Half-Hearted Laws for a Whole Earth

*Ian C. T. Nisbet, who writes regularly for* Technology Review, *is Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. in Physics is from Cambridge University.*

The passage of the Toxic Substances Control Act in 1976 signalled the completion of U.S. legislation for environmental protection. Since then attention has shifted from enactment to implementation. But unless one takes the narrow view that "environmental protection" means nothing more than pollution control, the existing laws are insufficient.

Probably the major legislative gap is provision for federal control or guidance of land-use decisions. Apart from specific laws governing management of federally owned lands, and the Coastal Zone Management Act (which provides little more than federal funding for state planning), the most significant federal laws governing land use are certain provisions of the Water Pollution Control Act and amendments to the Clean Air Act. These indirectly influence land development by subsidizing sewers and limiting regional air pollutant emissions. Many provisions of pending legislation on energy are likely to have similar indirect effects on patterns of land development. Unfortunately, these accidental forms of land-use control are at least as likely to promote irrational patterns of development as environmentally sound ones.

Federal law also fails to address resource conservation very adequately. As energy and minerals become more expensive, we need legislative initiatives to discourage consumption of virgin materials and to promote conservation and recycling. Many federal laws that encourage extraction and consumption of resources, such as the Mining Act of 1872 and the Price-Anderson Act, must be reversed; and fiscal reforms, such as replacing depletion allowances with severance taxes, should be introduced.

Still other environmental areas suffer broad gaps in federal policy and legislation: for example, population, water supply, indoor pollution, urban restoration, nutrition, and ecological agriculture. Indeed, one might argue that the federal legislation of the last eight years is fashioned to treat only symptoms of environmental problems and not the underlying causes.

While we wait for the public to recognize the importance of these issues and lobby for government initiatives, the most pressing need is for effective implementation of environmental laws already passed (*see box*). Here the picture is almost uniformly dismal. While the new legislation has revolutionized the statute books, it has not yet revolutionized the environment. It is hard to tell which group is the more frustrated — the environmentalists who worked to have the laws enacted and see them implemented tardily, minimally, and inefficiently, or the affected industries which bear the economic and bureaucratic burdens of abatement measures that are economically inefficient and environmentally ineffective.

The history of existing legislation follows a depressing general pattern. Typically, an environmental problem gradually worsens until its effects become so serious that it can no longer be ignored. *Ad hoc* environmental organizations spring up to raise public awareness and to press for remedial action. A comprehensive bill is introduced into Congress, meets sharp opposition from powerful interests that would be adversely affected, and is defeated in committee. Legislative coalitions are formed on two (or more) sides of the issue and compete for public and congressional attention, while the environmental problems worsen and become even more intractable. Two or three years later, an environmental crisis occurs and Congress takes decisive but ill-considered action. A compromise bill is passed with some heady language in the preamble, some dangerously vague wording in the key regulatory provisions, a substantial degree of administrative discretion in implementation, and some emasculating amendments that either restrict effective regulation or open the doors to endless administrative and judicial hearings.

Passage of a law is only the beginning of a complex process. Before a law can be implemented and enforced, regulations must be adopted — both general implementing regulations and specific rules applicable to individual cases. Implementation of an environmental law is characteristically entrusted to a regulatory agency having inadequate staff, experience, and funds. The agency's first activities are to assign responsibilities, commission studies, appoint task forces, and establish bureaucratic hierarchies. Most of

Illustration: Michael Crawford

the individuals who are competent enough to implement the act have gained their experience in or around the industry to be regulated, and as a result are often too sympathetic to its interests. Reports and proposals are commissioned, prepared, circulated, withdrawn, rewritten, recirculated, and redrafted. The industry either waits for proposals to emerge, or works discreetly behind closed doors for favorable regulations, while most environmental groups forget the issue and move on to others.

One or two years after the statutory deadline, proposed general implementing regulations are issued in draft form. They are attacked vigorously by industrial representatives, and faintly by one or two environmental groups that have kept abreast of the issues. The regulations are withdrawn, rewritten, and finally emerge after another year or two, weakened and rendered inconsistent by outside lobbies and inside bureaucratic compromises.

Meanwhile, an environmental group has petitioned or sued the agency for failing to meet statutory deadlines. Acting under pressure or court order, the agency issues its first standards and specific regulations in haste, often with incomplete scientific support. The affected companies, exercising their legal rights, call for full administrative and judicial review, tying up the scientific and legal resources of the agency for months or years, and thus delaying implementation of other parts of the act. When final standards are promulgated, their enforcement is slow, difficult, and inconsistent.

Finally, because implementation of the

act inevitably affects certain segments of industry more seriously than others, Congress is pressured to amend the act, and the whole process returns to the beginning. Formulation and implementation of amended regulations follow the same protocol, made more complex and difficult the second time around by the presence of a pre-existing bureaucracy with set positions on the issues.

**Inadequate Authority**

This history of a "typical" environmental statute may not fit any individual act precisely, but it is a good deal more than a caricature. Implementation of an environmental law has three seemingly inevitable features: delay, waste of resources, and piecemeal application. The adversary nature of the regulatory proceedings does not bring industry to a halt, as is sometimes claimed, but it does cause unconscionable delays. As a result, regulatory resources are pre-empted by limited issues while action on other, often more urgent, issues is postponed. Thus implementation of environmental laws not only has been slow and ineffective, but often has been uneven and inequitable.

The blame for this situation does not lie with intransigent industrialists, zealous environmentalists, or incompetent bureaucrats — although all three types are abundant enough. The principal blame should be placed squarely upon Congress, which adopts legislation that cannot be implemented effectively and efficiently.

Recent environmental laws have four general characteristics in common:

☐ Their major provisions tend to be worded vaguely, which encourages endless bureaucratic debate in formulating and implementing regulations.

☐ They provide for restrictive regulation and enforcement, which encourages affected parties to make legal challenges and to seek delays. A law combining pollution taxes with abatement incentives would be much more likely to speed response.

☐ Many laws do not provide specifically for cost-benefit comparison of alternatives, so that regulations are usually not applied in economically efficient sequence.

☐ Most of the laws provide only for restrictive regulation of damaging activities, foreclosing the option of actively promoting less damaging activities.

Among current environmental laws, the Toxic Substances Control Act (1976) is one of the few that provides for anticipating future problems and taking preventative action. The Resource Recovery and Conservation Act (1976) is one of the few that encourages positive management of environmental problems. But the effectiveness of both these acts is limited by inadequate authority. We must re-think our approach to environmental problems if legislation is to yield more than a frustrating inequity. ☐

## A Catalogue of Environmental Legislation

The series of environmental laws enacted in the U.S. in the past decade marks — at least in language and intent — a revolutionary change in attitudes toward environmental protection. Following the all-embracing National Environmental Policy Act of 1969, the most important pieces of legislation have been major amendments to the Clean Air Act (1970 and 1977), the Federal Water Pollution Control Act (1972), and the Federal Insecticide, Fungicide, and Rodenticide Act (1972), together with new initiatives such as the Wilderness Act (1964), the Endangered Species Act (1973), the Toxic Substances Control Act (1976), and the Resource Conservation and Recovery Act (1976). In addition, there have been many other pieces of legislation which address specific environmental problems or establish specific types of protection: wild and scenic rivers, marine mammals, occupational safety and health, marine sanctuaries, safe drinking water, national forest management, fish and wildlife coordination, coastal zone management, noise, administration of federal lands, Alaskan native claims, boundary waters, migratory birds, consumer product safety, and so on. — *I.C.T.N.*

# Reassessing the Profit Motive

*Ethics and Profits: The Crisis of Confidence in American Business*
Leonard Silk, David Vogel
New York: Simon and Schuster, 1976, 251 pp.; $8.95

**Reviewed by William F. Bottiglia**

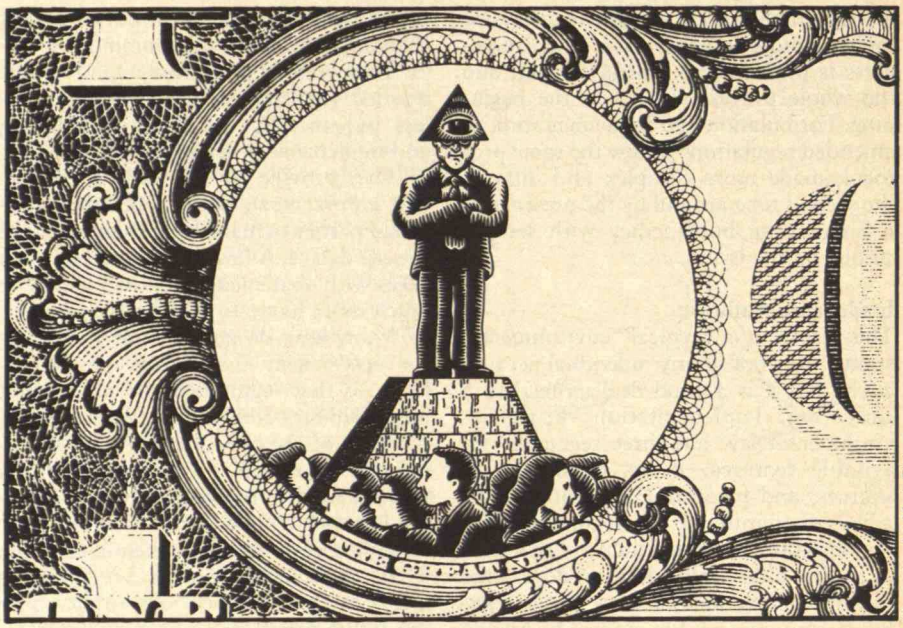


Illustration by Mark Fisher

In 1974-75, The Conference Board (an organization of business leaders concerned with national economic issues) sponsored a series of eight three-day meetings at which high-level corporate executives discussed the social responsibility of business, its political role, and related problems. Leonard Silk, economist on the Editorial Board of the *New York Times,* and David Vogel, Assistant Professor of Business Administration at the University of California at Berkeley, were asked to sit in on these sessions as observers, and then to write a book which would both report and evaluate the views expressed. The participating executives were assured of anonymity, and so spoke their minds with candor. Save for this assurance, authors Silk and Vogel were guaranteed complete freedom. The result is a work of the highest interest and importance, not only for managers and prospective managers but for all citizens concerned about the interrelationships between the economic sector and the whole of American society.

**What's Good for General Motors . . .**

The discussions reveal a business leadership which for the most part continues to affirm its faith in the classical laissez-faire ideology. Entrepreneurs producing goods or services for private profit, and competing in a market governed exclusively by the law of supply and demand, hence free of government interference, will promote both their own interest and that of society. Guided by this creed, most of the discussants interpret their social responsibility as including production, profits, growth, the payment of taxes — and purely *voluntary* contributions to the health and safety of their employees, the protection of consumers and the environment, and other such goals. Many declare that they *are* willing to respond to new social demands, but only to the extent that these do not endanger the profitability, and consequently the viability, of the private sector.

American business executives hold that their faith in laissez-faire has been amply, even spectacularly, justified by works; for it is the free enterprise system that has, with unprecedented success, provided the material abundance which alone makes possible the pursuit of qualitative ends. Since they play leading roles in this crucial activity, they feel entitled to their high rewards, to the respect of individuals and groups not involved in economic production, and to the allegiance of the citizenry at large.

During the past decade, however, a number of developments have encouraged a precipitous decline of public confidence in business: notably stagflation, unemployment, alleged profiteering by big oil in connection with the energy crisis, disclosures of corrupt corporate practices both here and abroad, and well-publicized charges of corporate insensitivity to issues of social responsibility that transcend production, profits, growth, and the payment of taxes. A solid majority of executives reject the implication that the unscrupulous behavior of a few companies is typical of the business community as a whole. What is more, they place the blame for the current ills of our society on others: inefficient bureaucrats, economically irresponsible politicians, economically ignorant voters, politically active union leaders; distorting, sensation-mongering journalists and newscasters; intellectuals hostile to the system. Sincerely troubled by what they view as an ever-increasing incompatibility between free enterprise and democracy, and at the same time convinced that the electorate would support free enterprise if properly informed, they accuse themselves of political ineptitude and ponder ways to become effectively involved. For example, they would require high-school courses in economics, or contribute only to institutions of learning that give fair play to competitive capitalism, or fund seminars on the principles of free enterprise for the enlightenment of college and university professors, or combine to buy a controlling interest in a television network.

**Popular Sovereignty**

Messrs. Silk and Vogel ably expose the grave weaknesses of this old-time religion and of the specific proposals it generates. In clinging to it, corporate executives betray their social and political narrowness. As specialists, they tend to equate the economic sector with the whole of American society, and so fail to appreciate the need for a healthy tension between business and government; business and academia; and between business and the media. The academic community and the communications media in particular must be free to inquire and to criticize, lest business abuse its power. This is essential today because "corporate decisions affect the relative prosperity of various regions of our nation, the development of foreign nations, submission or resistance to foreign boycott threats, discrimination or nondiscrimination against blacks, women, Jews, or other social groups, the future of cities, the quality of urban life, the retirement income of the aged, the development and conservation of energy, the state of the environment, and even the viability of human life itself."

In addition, there is an obvious credibility gap between rhetoric and performance on the part of free enterprisers who lobby for government defense contracts, or who, when threatened with bankruptcy, ask the government to bail them out. Often enough laissez-faire is seen unidirectionally: government should never intervene to monitor, regulate, or punish — but always to provide what business wants or needs.

Messrs. Silk and Vogel argue persuasively that, "in response to new objective conditions and to new social demands," America's business leaders must discard their outworn ideology. They must adapt creatively to a mixed economy by modifying competitive capitalism in order to preserve it.

To that end, say the authors, our corporate executives must show themselves to be individuals "of firm and deep moral principle," and must insist on high standards of conduct throughout their organizations. These standards "must now be made more humane and sensitive to the needs and aspirations of all people." Profit-seeking is no longer enough. The legitimacy of the modern corporation must be based on "the doctrine of public consent" or popular sovereignty. In sum, authors Silk and Vogel call upon our business managers to work toward an effective synthesis of capitalist, democratic, and Judeo-Christian moral values — a synthesis which alone can keep the nation productive while bringing it closer to the ideal of social justice and enhancing its chances of long-term survival. The "most politically and socially astute" among them, as the authors point out, are already thinking along these lines.

The one disappointing element of this generally excellent book is the vagueness of its concluding recommendations. If our captains of business and industry are to break free of a fossilized creed and gain breadth of perspective, they need more practical guidance than the homiletic reminder that greed is sin and altruism virtue. However, I think it fair to infer from the book that the authors would advise reading and reflection; seminars on free enterprise and social responsibility; discussions which would include participants of more than one generation and from various sectors of the society; and finally, the appointment of task forces to devise policies and proposals for action. As for reading, the ideal book with which to begin would be *Ethics and Profits*.

*William F. Bottiglia is Professor of Management and Humanities at M.I.T.* □

# An Architecture for the Knights of Columbus

*Bernini Is Dead? Architecture and the Social Purpose*
John Burchard
New York: McGraw-Hill, 1976, 631 pp.; $30

**Reviewed by Nicholas Adams**

The study of architectural history in this country is not easily undertaken. No matter how many buildings one visits, or how many local comparisons one draws, the sources of American architecture are almost invariably European. Boston's 18th century chapels reflect English Palladian models, and the sources for our rich, 19th century Gothic styles are found in the original European Gothic of the 12th, 13th, and 14th centuries. It is, I suspect, the fact that we are condemned to be an architecturally derivative culture that has lead John Burchard to write *Bernini Is Dead?*

Dr. Burchard sought to resurrect the great architectural heroes of time past, exemplified by the Italian architect Gian Lorenzo Bernini. He wanted to seek out the original forms and expected us to study and love them as he did. And so he has written a kind of layman's primer to the architecture of originality: the Gothic, Greek, Romanesque, Japanese, and Islamic. Styles such as 19th century neo-Gothic (imitative) or Renaissance (imitative) or Neo-classical (twice imitative) receive short shrift.

**An Oriental Dome on the Armory**

I confess that I do not share Dr. Burchard's convictions or tastes — not just because I like American or neo-Gothic architecture (I do), but because I take great pleasure in the play of derivative architecture. There is a refreshing irony in derivative styles that is quite lacking in the high seriousness of Amiens Cathedral or the Pantheon.

An oriental dome on an armory? A church made from a Greek temple and an Italian campanile? An 18th century Georgian chapel in the style of a Gothic cathedral? In the recognition of the fusion of these styles there is a light-heartedness. We laugh when we notice their union and smile at the way two architectural styles live side by side.

These light-hearted effects are not specialized products of dictionary learning. We do not need to know the five orders or the nature of the hexostyle to see how things belong to two styles at the same time. And the discovery that architecture, not just buildings, is all around us — like the discovery that we speak in prose — is a useful first step.

Dr. Burchard longs for the return of a giant such as Bernini. But perhaps our own age deserves no more than an eclectic style. Kevin Roche and John Dinkeloo, two of the most respected modern architects, designed a head office for the Knights of Columbus in New Haven, Conn., that is for all the world a medieval castle. Its square floor plan is surrounded by four circular towers at the corners. It could be the 13th century Castel del Monte in southern Italy, transformed into modern materials. There is nothing shameful in this borrowing. Indeed, the amusement we feel when we observe the medieval antecedents of the form and think of its association with these modern knights is appropriate and genuine. Nor do I think that we laugh only once in contemplating this building. Our humor does not wear thin, for the building is interesting beyond these associations.

Indeed, architecture is not alone in its eclecticism. We have no heroic figures in painting, music, or writing, either. But to look back to heroic figures or heroic ages with longing can do little good. The more we concentrate on the past, the more debased our style; so perhaps Dr. Burchard would say. And so why should we not admit the fact and learn to understand and enjoy what there is around us?

**Shock of Style**

Humor is an emotion that we don't take seriously. It is as impolite to laugh in a concert hall as in an art gallery, even though funny things happen in both places. But as most teachers know, one of the best ways to capture a student's attention is through humor. Not false humor, like a Johnny Carson monologue, but through the engrained humor, the essential humor, of a work of art. Humor in architecture? Surely we must do something more than gawk at the church of Notre Dame in Montreal with its bizarre mixture of English Georgian and Gothic. How brilliant! How incredible! The most turgid Gothic united with a monumental Georgian produces a clash, a shock of style. Laughter releases the strained emotion, makes the building fun.

Dr. Burchard, in fairness, advocates

*Continued on p. 29*

# Baseball: Action But No Score

*Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Activities in the Mathematics Department at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.*

Happy New Year. I have received several comments concerning our latest addition to Puzzle Corner — the Editor's picture. The consensus seems to be that as a photographer's model I make a good computer scientist-mathematician. But every engineer knows that one can learn to make do with the material available.

**Problems**

This being the first issue for the new year, we begin with our yearly problem: **Y1978.** Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 7, and 8 once each and the operators +, −, * (multiply), / (divide), and ** (exponentiation). We desire solutions containing the minimum number of operators. For a given number of operators, solutions using the digits in the order 1, 9, 7, and 8 are preferred. The solution to **Y1977** is given below.

**JAN 1** We start this month's regular problems with a bridge question from Kenneth Lebensold:
Included with his solution to **1975 FEB 1** were two related questions: What is the largest contract that can be made from three positions on the same deal? From four positions? Assume best defense.

**JAN 2** J. Kleilin and Bob Martin can find, for each n and each j, integers $X_1, X_2, \ldots, X_j$, W, and Z such that $X_1^n + X_2^n + \ldots + X_j^n = W^{n-1} = Z^{n+1}$. Can you?

**JAN 2** Seville Chapman writes:
Nearly 40 years ago Ripley had a problem which yielded me and 102 others in the country his autographed book: How can a baseball team make three triples, one double, two singles, and steal two bases in one inning without scoring a run?

**JAN 4** Bruce Hannon wants us to prepare for a tornado attack:
Suppose you suddenly realize that you are (on foot) directly in the path of a mid-western tornado which is approaching with a speed of $V_T$. The tornado has a lethal radius of $R_L$. You wish to take a path which maximizes your chance of survival. Your speed is a − bt (in which a and b are positive constants). In which direction should you head, and will you escape?

**JAN 5** A space-age problem from Harvey Elentuck:
A satellite is orbiting Earth and is now directly above Chicago. How far from the center of the earth is the satellite if New York City and Los Angeles bound the horizon? You are given the following information:

| | *Latitude* | *Longitude* | *Altitude* |
|---|---|---|---|
| New York | 40°45′06″N | 73°59′39″W | 55 feet |
| Chicago | 41°52′28″N | 87°38′22″W | 595 feet |
| Los Angeles | 34°03′15″N | 118°14′28″W | 340 feet |

The diameter of Earth is 7926.69 miles.

**Speed Department**

**JAN SD 1** This quicky is from Glenn Rowsam:
Two men were playing chess. They played five games and each man won the same number of games. How is this possible if no draws occurred?

**JAN SD 2** We end with a question from David and Aviva Eichler:
A shopper who is in a rush and is carrying heavy bags is going from Point A to Point B on a route which includes an escalator. He is tired and must rest. Should he rest on or off the escalator to save time? Or does it matter? (If he rests off the escalator he then actively walks up the moving escalator.)

**Solutions**

**Y1977** Take the digits 1, 9, 7, and 7; and the operators +, −, * (multiply), / (divide), and ** (exponentiation); and form the integers from 1 to 100 using each digit once (7 is thus used twice) and the fewest possible number of operators. Parentheses may be used to indicate the order of operations and, in the case of a tie, the solution using 1, 9, 7, and 7 in order is to be favored.

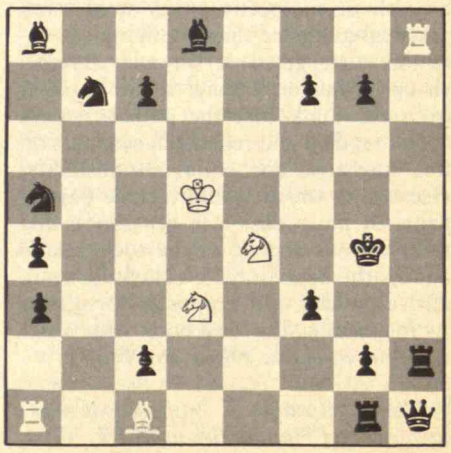
The problem is more difficult than usual due to the repeated digit. There are apparently 26 unattainable numbers. I can hardly wait for 1999 (or 2222). Two readers sent in computer printouts, and others included acknowledgements to H-P, T.I., etc.

An optimal solution is:

| | | | |
|---|---|---|---|
| 1 | 1** 977 | 51 | 9 − [(1 − 7) * 7] |
| 2 | 1 + [9** (7 − 7)] | 52 | − |
| 3 | [(1**7) + 9] − 7 | 53 | − |
| 4 | (1 + 7)/(9 − 7) | 54 | 9 * [7 − (1 ** 7)] |
| 5 | 19 − 7 − 7 | 55 | 71 − 9 − 7 |
| 6 | (91/7) − 7 | 56 | (17 − 9) * 7 |
| 7 | (1 ** 97) * 7 | 57 | 1 + [(9 * 7) − 7] |
| 8 | 79 − 71 | 58 | 77 − 19 |
| 9 | (1 ** 77) * 9 | 59 | 1 + 9 + (7 * 7) |
| 10 | (1 ** 77) + 9 | 60 | − |
| 11 | 1 + 9 + (7/7) | 61 | [9 * (7 − 1)] + 7 |
| 12 | (91 − 7)/7 | 62 | 79 − 17 |
| 13 | [(9 − 7) * 7] − 1 | 63 | [(1 + 9) * 7] − 7 |
| 14 | 91 − 77 | 64 | (1 + 7) ** (9 − 7) |
| 15 | (17 − 9) + 7 | 65 | [(1 + 7) * 9] − 7 |
| 16 | [(1 ** 7) * 9] + 7 | 66 | − |
| 17 | [(1 ** 7) + 9] + 7 | 67 | 77 − 1 − 9 |
| 18 | 19 − 7/7 | 68 | 19 + (7 * 7) |
| 19 | 19 + 7 − 7 | 69 | (1 − 9) + 77 |
| 20 | 19 + 7/7 | 70 | [(1 * 9) * 7] + 7 |
| 21 | [(1 + 9) − 7] * 7 | 71 | 79 − 1 − 7 |
| 22 | [(9 − 1) + 7] − 7 | 72 | (1 * 79) − 7 |
| 23 | [(1 * 9) + 7] + 7 | 73 | (1 + 79) − 7 |
| 24 | 1 + 9 + 7 + 7 | 74 | − |
| 25 | − | 75 | − |
| 26 | 97 − 71 | 76 | 77 − (1 ** 9) |
| 27 | − | 77 | (1 ** 9) * 77 |
| 28 | − | 78 | (1 ** 9) + 77 |
| 29 | − | 79 | (1 ** 7) * 79 |
| 30 | 7 * 7 − 19 | 80 | 97 − 17 |
| 31 | − | 81 | 9 ** 1 + (7/7) |
| 32 | − | 82 | − |
| 33 | 19 + 7 + 7 | 83 | − |
| 34 | 17 * (9 − 7) | 84 | (19 − 7) * 7 |
| 35 | − | 85 | 9 − 1 + 77 |
| 36 | (7 − 1) ** (9 − 7) | 86 | (1 * 9) + 77 |
| 37 | − | 87 | 1 + 9 + 77 |
| 38 | − | 88 | − |
| 39 | (7 * 7) − 1 − 9 | 89 | 97 − 1 − 7 |
| 40 | (1 * 7 * 7) − 9 | 90 | (1 * 97) − 7 |
| 41 | (1 − 9) + (7 * 7) | 91 | (1 + 97) − 7 |
| 42 | 91 − (7 * 7) | 92 | 91 + 7/7 |
| 43 | − | 93 | − |
| 44 | − | 94 | − |
| 45 | — | 95 | − |
| 46 | (9 * 7) − 17 | 96 | 19 + 77 |
| 47 | [(1 + 7) * 7] − 9 | 97 | (1 ** 7) * 97 |
| 48 | [7 ** (9 − 7)] − 1 | 98 | (1 ** 7) + 97 |
| 49 | [(1 ** 9) * 7] * 7 | 99 | − |
| 50 | 1+ [7 ** (9 − 7)] | 100 | − |

Solutions from Avi Ornstein, H. W. Hazand, Howard Reuter, Igor Limansky, W. V. McGuinness, Richard Rudel, John Richards.

**J/A 1** White forces a draw, White to move.



This was a good problem. The following solution is from Randy Kimble:

1 N—K5 ch K—B4 forced
2 N—N3 ch K—B3 forced
3 N—N4 ch K—K2
4 N—B5 ch K—Q2 forced
5 N—K5 ch K— B1 forced

*(If Black's response in 3 is K—N3, then*
*4 N—K5 ch K—B3*
*5 N—N4 ch*
*and Black must eventually play K—K2 or the game is drawn by repeating the same position three times with the same player to move.)*

6 N—K7 ch K—N1 forced
7 N—Q7 ch K—R2 forced
8 N—B8 ch K—R3 forced
9 N—N8 ch K—N4 forced
10 N—R7 ch K—N5
11 N—R6 ch K—B6

*(If Black's response in 10 is K—N3, then*
*11 N—B8 ch K—N4*
*12 N—R7 ch*
*and Black must eventually play K—N5 or draw by repeated position.)*

12 N—N5 ch K—Q6

*(If Black's response in 11 is K—N6, then*
*12 R x P mate.)*

13 N—N4 ch K—K7

*(If Black's response in 12 is K—N6, then*
*13 R x P mate.)*

14 N—B3 ch K—B7
15 N—Q3 ch K—N6

*(If Black's response in 14 is K—K8 or K—B8, then*
*15 B—K3 ch P—B8(Q)*
*16 R x Q mate.)*

16 N—K4 ch K—N5

*(If Black's response in 15 is K—B8, mate results.)*

After 16 moves, the original position is restored. White can chase Black around the board again and then claim a draw when the position reappears for the third time.

Also solved by William Butler, Robert Saunders, Bill Camperlino, Steve Grant, Jeffrey Miller, Jerome Taylor, Bill Wilbur, Martin Donovan, John McCauley, John Chandler, and the proposer, Bob Kimble.

**J/A 2** Find the smallest number which can be partitioned in six distinct positive integers such that the sum of any five of these six is a perfect square.

Adding like terms:
$r^2 - 30r + 55 > 0$,
or $4(r - 30) + 55 > 0$.
The smallest r satisfying this relationship is 29 since
$-29 + 55 > 0$, but $28(-2) + 55$ is $-1$ and $< 0$.
Also, any r larger than 29 will also satisfy the relationship.

Diminishing the size of any or all of the five squares other than $r^2$ does not permit a smaller r:

1. Diminishing the smallest of the squares, $(r-5)^2$, to $(r-6)^2$ and leaving the other squares the same changes the inequality to $r(r - 32) + 66 > 0$; and 30 is the smallest r that will satisfy it since $(30)(-2) + 66 > 0$, but $29(-3) + 66$ is $(-87 + 66)$, which is negative.
2. Retaining $(r-6)^2$ and diminishing $(r-4)^2$ to $(r-5)^2$ changes the inequality to $r(r-34) + 75$; and 32 is the smallest r that will satisfy it, since $32(-2) + 75$ is $+11$ while $31(-3) + 75$ is $-18$ and $<0$.
3. Other changes diminishing the size of any of the squares obviously, therefore, increase the size of the r that will satisfy the arrangement.

It follows that $(29^2 + 28^2 + 27^2 + 26^2 + 25^2 + 24^2)$ is the smallest sum of six different squares that will be larger than $5 \cdot 29^2$. While this sum satisfies this requirement of the problem, it does not satisfy the requirement that the sum be divisible by 5. In the series of perfect squares, not only are the squares of 5 and its multiples divisible by 5; between each such square and the next higher such square, there are always two pairs of squares the sum of each of which is divisible by 5. Therefore, to be divisible by 5, a sequence of six squares consisting of $r^2 + (r-1)^2 + \ldots + (r-5)^2$ must comprise the square of each of two adjacent multiples of five and the four intervening squares. The next higher value of r which satisfies this requirement is 30. As shown above, there are only two sequences of squares with r = 30 which satisfy the requirement that the sum of the squares $> 5 \cdot 30^2$. They are

(1) $30^2 + 29^2 + 28^2 + 27^2 + 26^2 + 25^2$, and
(2) $30^2 + 29^2 + 28^2 + 27^2 + 26^2 + 24$.

The following detailed solution is from Frederick Nash:

Let x = the desired number; A, B, C, D, E, and F the positive distinct integers into which x is to be partitioned; and m, n, o, p, q, and r the numbers which are to be squared. Then

$x = A + B + C + D + E + F$, and

| | | |
|---|---|---|
| $m^2 = A + B + C + D + E$ | $x - m^2$ | $= F$ |
| $n^2 = A + B + C + D + E + F$ | $x - n^2$ | $= E$ |
| $o^2 = A + B + C + E + F$ | $x - o^2$ | $= D$ |
| $p^2 = A + B + D + E + F$ | $x - p^2$ | $= C$ |
| $q^2 = A + C + D + E + F$ | $x - q^2$ | $= B$ |
| $r^2 = B + C + D + E + F$ | $x - r^2$ | $= A$ |

$x - m^2 + x - n^2 + x - o^2 + x - p^2 + x - q^2 + x - r^2 = A + B + C + D + E + F = x$,
or $6x - (m^2 + n^2 + o^2 + p^2 + q^2 + r^2) = x$,
or $5x = m^2 + n^2 + o^2 + p^2 + q^2 + r^2$,
$x = (m^2 + n^2 + o^2 + p^2 + q^2 + r^2)/5$.

By hypothesis, x is an integer. Therefore $m^2 + n^2 + o^2 + p^2 + q^2 + r^2$ must be evenly divisible by 5. Assuming that $r^2$ is the largest of the squares, the next problem is to find the smallest $r^2$ such that $x - r^2 > 0$, for the smallest $r^2$ will yield the smallest x.

Since $x = (m^2 + n^2 + o^2 + p^2 + q^2 + r^2)/5$, the problem may be restated as finding an $[(m^2 + n^2 + o^2 + p^2 + q^2 + r^2)/5] - r^2 > 0$, or $m^2 + n^2 + o^2 + p^2 + q^2 - 4r^2 > 0$, or $m^2 + n^2 + p^2 + q^2 + r^2 > 5r^2$.

If $r^2$ is the largest of the squares and all squares are different (as they are, by hypothesis), then the other five squares cannot be larger than $(r-1)^2$, $(r-2)^2$, etc. Substituting these in the above inequality and expanding:
$(r^2 - 2r + 1) + (r^2 - 4r + 4) + (r^2 - 6r + 9) + (r^2 - 8r + 16) + (r^2 - 10r + 25) - 4r^2 > 0$.
But only the first is divisible by 5, and it is the smallest sequence of squares that satisfies both requirements. The answer to the problem is, therefore, obtained by adding this sequence, dividing the sum by 5, and partitioning the result in accordance with the equations shown in italics in my statement of the problem,

$25^2 = 625$
$26^2 = 676$
$27^2 = 729$
$28^2 = 784$
$29^2 = 841$
$30^2 = 900$
$5 \quad 4555$

| | | |
|---|---|---|
| $x - r^2 = 911 - 900 =$ | $11$ | $= A$ |
| $x - q^2 = 911 - 841 =$ | $70$ | $= B$ |
| $x - p^2 = 911 - 784 =$ | $127$ | $= C$ |
| $x - o^2 = 911 - 729 =$ | $182$ | $= D$ |
| $x - n^2 = 911 - 676 =$ | $235$ | $= E$ |
| $x - m^2 = 911 - 625 =$ | $286$ | $= F$ |
| | $911$ | |

$x = 911 = 11 + 70 + 127 + 182 + 235 + 286$.

Proof:

$A + B + C + D + E = 625 = 25^2$
$A + B + C + D + F = 676 = 26^2$
$A + B + C + E + F = 729 = 27^2$
$A + B + D + E + F = 784 = 28^2$
$A + C + D + E + F = 841 = 29^2$
$B + C + D + E + F = 900 = 30^2$.

Also solved by Edward Parks, Frank Carbin, Steve Grant, Bob Lutton, Jacob Bergman, Neil Cohen, Judith Longyear, Raymond Gaillard, Alan LaVergne, William Rosenfeld, Charles Rozier, David Gluss, Harvey Elentuck, Emmet Duffy, Gerald Blum, Steve Clarke, William Butler, Bill Wilber, John Chandler, Winslow Hartford, Harry Zaremba, and the proposer, P. V. Heftler.

**J/A 3** Assume a fixed number of buttons can fit on a calculator. In order to maximize the total number of functions, how many buttons should be "primary" keys and how many should be "shift" keys? (Each "primary" key gives one function if depressed alone and a different one if depressed with different "shift" keys. No more than one "shift" key may be used at once.) After answering the question with those rules, try lifting the last restriction.

The problem did not indicate whether more than one shift key can be depressed at once. If this is allowed, the number of possibilities is $2^x y$, where x is the number of shift keys and y the number of function keys. As Frank Rubin points out, this is maximized when there is exactly one function key. Most likely the intent was to allow only one shift key to be depressed at one time (as in current calculator designs). In this case, the number of possibilities is (x + 1)y. Daniel Cheng found the maximum to occur when $x = \frac{1}{2}(b - 1)$, where b is the number of buttons. When the latter is non-integral, you may round it either up or down. Maximums were obtained by the usual derivative test.

Also solved by Morrie Gasser, William Rosenfeld, Charles Rozier, David Gluss, Steve Clarke, William Butler, John Chandler, Frank Carbin, Michael Kennedy, Naomi Markovitz, Raymond Gaillard, Neil Cohen, Steve Grant, Edward Parks, Jordan Wouk, Robert Saunders, and the proposer, Joe Horton.

**J/A 4** How many times must a deck of cards be shuffled before it returns to the same order? Assume 52 cards and a perfect, nonconservative shuffle — one in which the first card on shuffle j is the second on shuffle j + 1.

The following is from Gordon Cochrane: A deck of cards must be shuffled 52 times before it returns to the same order. It is necessary to assume a perfect, nonconservative shuffle each time in which the deck is divided in half and the cards from one half are interspersed uniformly with the cards from the other half, with the first card in shuffle j being the second card in shuffle j + 1. The position of any card in shuffle j + 1 is determined according to the following rule:
If the position of any card, P, (counting from the top of the deck) on shuffle j is equal to or less than 26, the position in shuffle j + 1 is 2P. If the position P is greater than 26 in shuffle j, then the position in shuffle j + 1 is equal to (P − 26) 2 − 1. The card which is initially at the top of the deck takes the following positions in the 52 shuffles:

1 2 4 8 16 32 11 22 44 35 17 34 15 30 7 14 28 3 6 12 24 48 43 33 13 26 52 51 49 45 37 21 42 31 9 18 36 19 38 23 46 39 25 50 47 41 29 5 10 20 40 27 1

Also solved by Randy Kimble, M. G. Settle, Bruce Andeen (who sent in some computer runs for a more general problem), Alan LaVergne, Bob Lutton, Steve Grant, Neil Cohen, Raymond Gaillard, Michael Kennedy, John Chandler, William Butler, Steve Clarke, Charles Rozier, and Frank Rubin.

**J/A 5** Find an integer solution to:

$$\frac{A^4 + B^4 + C^4}{A + B + C} = 39.$$

All respondents found the solution 1,2,4; but Steve Grant was among the few to prove it unique. His analysis follows:
Let m be the maximum of |a|, |b|, |c|. then
$m^4 \le a^4 + b^4 + c^4$, and $3m \ge a + b + c$. Thus
$m^3/3 \le (a^4 + b^4 + c^4) / (a + b + c) = 39$, and hence $m \le 4$.
This shows that a, b and c must be 0, ±1, ±2, ±3, or ±4.

| $x$ | $x^4$ | $x^4$ *(mod 39)* |
|---|---|---|
| 0 | 0 | 0 |
| ±1 | 1 | 1 |
| ±2 | 16 | 16 |
| ±3 | 81 | 3 |
| ±4 | 256 | 22 |

Since $a^4 + b^4 + c^4 \equiv 0 \pmod{39}$, the above table shows that the only possibilities (up to permutations) are $(a^4, b^4, c^4) \equiv (0, 0, 0) \pmod{39}$ or $(a^4, b^4, c^4) \equiv (1,16,22) \pmod{39}$. But (0,0,0) gives a zero denominator in the original problem. Thus (a,b,c) = (±1, ±2, ±4). Since $a + b + c = (a^4 + b^4 + c^4)/39 = 273/39 = 7$, (a,b,c) = (1,2,4) is the unique solution (up to permutations).

Also solved by Randy Kimble, Bob Lutton, Robert Saunders, Jordan Wouk, Edward Parks, John Chandler, Alan LaVergne, Neil Cohen, Frank Carbin, David Gluss, William Rosenfeld, Michael Kennedy, William Butler, Steve Clarke, Morrie Gasser, Charles Rozier, Frank Rubin, Judith Longyear, Harvey Elentuck, Gerald Blum, Winslow Hartford, John Podolsky, Harry Zaremba, Raymond Gaillard, P. V. Heftler, and Avi Ornstein.

**Better Late Than Never**

**1976 J/A 1** John Podolsky points out that the simplification given recently is unattainable since the White KB cannot reach Q1 without movement of the KP or QBP.

**1977 JAN 1** James Prigoff and Smith Turner have responded.

**FEB 2** Judith Longyear notes that a solution by Meredith and Lloyd appears in the *Journal of Combinatorial Theory (B)* 15 (1973), page 161.

**FEB 3** Peter Groot has responded.

**MAY 1** One of the solvers commented that the third move could be placed first, showing that the first move is not unique. Tom Jenkins and your Editor, however, feel that

1 P-KR4 K-B2
2 P-K4 K-N3
3 Q-R5 ck KxQ

refutes this.

**MAY 3** Frederic Vose has submitted the following comments:
This is a variant on a problem dealt with in Frederick Mostleller's *Fifty Challenging Problems in Probability* (Addison Wesley, 1965); Mr. Mosteller says that John von Neumann solved it in his head in 20 seconds. You are correct that the angular momentum of the toss cannot be handled and must be disposed of; Mosteller envisions the coin falling on a viscous bed which absorbs it. But it is not necessary to ignore the angular displacement of the coin, thereby allowing a plane geometric solution to a solid geometric problem. Consider the "super-coin" within a sphere tangent to the perimeters of its faces. The probabilities are proportional to the areas of the three zones into which the sphere is divided, in turn proportional to the thickness of the zones. Working it out to the nearest integer, N = 4 in case (a) and N = 14 in case (b).

**JUN 2** What is the maximum possible score for one player on one turn of a legal scabble match? The maximum possible score in a legal match?

Apparently a scrabble match is legal if a player uses non-words but is not challenged. However, I do not believe that was the intended problem and have not allowed such solutions; I apologize for the poor wording. The best (and most unbelievable) solutions were reports on a previous contest concerning this same problem. The following is from Frank Rubin:

This problem has been the subject of lively debate for several years in *Games and Puzzles* magazine. The winner of the first Scrabble Superscore Competition, for a single play, was Ron Jerome (the British R. Robinson Rowe) in the May, 1974, edition. He played BZYCHRS to form the word BENZOXYCAMPHORS as shown below, for 1,961 points.

```
          S       J
          Q       I
          U    EEVN
          A   EE AN
        ADNOTE   GY
         AD      AR
         FET     BI
P        FRO   G OC
RIEW     OM   QUINK
O  E     DA    LODS
V  RUTIN       L AH
E  T     LI    I GA
RI U ELAT     STEW
BENZOXYCAMPHORS
```

The full scrabble game in the second Superscore Competition was also won by Ron Jerome with the key word being ALEXIPHARMAKONS on the bottom row.

But, alas, Jerome's result of 3,881 was passed repeatedly after the close of the competition. The last effort I have seen was submitted by Ralph G. Beaman, below, and scores 4,153 points. The full sequence of moves is not given — only the final position. The game is Solitaire Scrabble, so that all 100 tiles have been used; otherwise, remove the S in "Mitigates," giving 4,142 points. The underlined letters are blank tiles.

```
JACKPUDDINGHOOD
OLEANDRINES
  ETE I
   EU
    MITIGATS
   TA
  VA          B
PREQUALIFYING E
  LU         ARF
  VA           L
  E            O
  TS           W
  EW           E
ONEIROTIC      R
BENZOXYCAMPHORS
```

Also solved by Gerald Ruderman, Ted Mita, Stuart Schulman, William J. Butler, Jr., Peter Groot, Donald Oestreicher, Donald Pratt, Nancy Burstein, Robert Moore, Bob Ferrara, and Harry Nelson.

**PERM 2** Harvey Goldman noticed that the term $.\sqrt{4} = .2$ opens up new possibilities. For example, let

$$z = \sqrt{\sqrt{\sqrt{(.\sqrt{4} ** (-4!)}}} = 125.$$

Then

$$73 = (.\sqrt{4} ** -\sqrt{4}) + 4! + 4!$$
$$77 = z - 4! - 4!$$
$$103 = z - 4! + \sqrt{4}$$
$$113 = z - 4! / \sqrt{4}$$
$$117 = z - 4*\sqrt{4}.$$

Frank Corbin has also responded.

**NS 6** Irving Hale notes that some of the clues are stronger than necessary.

**NS 8** Edward Parks, Steve Grant, and Harry Zaremba have responded.

**Proposers' Solutions to Speed Problems**

**JAN SD 1** The men were not playing against each other.

**JAN SD 2** All points off the escalator have exactly the same status, so if the shopper rests off the escalator we can assume, without loss of generality, that he is resting just before stepping onto it. But this is silly, in the interest of saving time, he might as well just get on and then rest.

# Trend of Affairs





## The Chemicals Nobody Wants

Each year American industries produce about 40 million tons of flammable, corrosive, toxic, and/or explosive chemical wastes. This staggering load is increasing by 5 to 10 per cent annually. About 30 million tons of these are potentially recoverable resources, but 10 million are true wastes with no built-in economic incentive — no profitable road to recovery.

Historically, wastes have been simply thrown away — untreated or nearly so — flushed down sewers, dropped off ships at sea, piped into lakes and rivers, injected deep underground, stored in tanks, and merely laid to rest in ordinary steel drums set in shallow trenches. Such disposal methods are relatively cheap and convenient, but their effectiveness is short-lived. Leakages that threaten life and property occur with alarming frequency.

The era of haphazard disposal is nearly over. Starting in the spring of 1978, U.S. industry will be faced with federal safety standards for hazardous waste disposal written under the authority of the Resource Conservation and Recovery Act (P.L. 94-580).

The act — it comes on the heels of the Safe Drinking Water Act of 1974 (P.L. 93-523), which prohibits the disposal of leachable hazardous wastes where they might seep into potable water supplies — is two-pronged. It encourages the extraction of useful materials from wastes, and it sets very specific standards for the safe generation, transportation, storage and disposal of wastes. These standards will require the dovetailing of new disposal technology and existing industrial processes. The Resource Conservation and Recovery Act makes disposal a particularly irksome task:

☐ Many of the wastes cannot be incinerated because their toxic materials could thus be launched into the atmosphere.

☐ Waste residues are created after some disposal techniques are used; these second-generation wastes complicate cleanup efforts because waste bins never seem to be completely empty.

☐ Reducing the production of waste at its source may mitigate, but certainly does not solve, the problem.

☐ The problems of dealing with growing inventories of toxic metal wastes, salts, acids, bases, and synthetic organic materials range from minor aggravation to major headache. For example, a large portion of the kepone generated by a chemical firm in Virginia is contaminated with mercury, chromium, lead, and arsenic. A disposal site for this poisonous waste could not be located, so it is being stored in a warehouse. Incineration is out of the question because of the danger of the toxic metal particulates going airborne. The sheer volume of wastes makes handling extremely difficult, dangerous, and expensive. As a result, the entire inventory still awaits disposal.

Another example: leaky sacks of toxic arsenic compounds are piled up in many barns in the Cotton Belt. These inorganic compounds were once applied to cotton plants to desiccate the bolls, defoliate the plants, and kill boll weevils; now they've been replaced with superior organic chemicals. Safe handling of the obsolete compounds is expensive, and many small farmers simply can't afford to hire disposal experts. So the toxins continue to trickle onto the floors of the barns.

Indeed, the cost of cleaning up existing inventories of wastes adds a political element to many disposal problems. Who will pay the bill?

The technologies of waste disposal — if not the politics — tend to be straightforward, but neither simple nor cheap, according to Robert B. Pojasek, Laboratory Manager of Energy Resources Co. (ERCO), an environmental consulting firm in Cambridge, Mass. The proper goal of disposal is permanent safety, he told a seminar at M.I.T. this fall. Dr. Pojasek makes the assumption that all containers eventually fail, so containerization alone is not the answer. He recommends that hazardous materials be converted to nonhazardous ones that can be safely handled and disposed of in familiar ways — for example, as landfill. However, in this example land used for waste disposal must never become a potential source of toxic effluents. Such land must retain some utility and remain accessible. In the most ideal of all solutions, processed wastes could be used in a productive manner, such as preparing roadbeds and lining waste disposal trenches, instead of being swept under the earth's crustal rug.

Dr. Pojasek proposes an intuitively appealing technique to remove the hazardous properties from troublesome chemical wastes: make them insoluble by containing them within an impervious solidifica-

Storing chemical wastes is not effective disposal. These synthetic organic wastes (top) corroded through their steel drum containers. (Photo: U.S. Environmental Protection Agency.) Stabilized wastes (bottom) can be used constructively to underlie a road, building or park. These are being placed in a structural landfill. (Photo: IU Conversion Systems)

tion agent. The resulting mass could be handled routinely. Such a process would relegate containerization to its properly temporary holding function, to be used perhaps while transporting the materials.

Numerous solidification processes are being tried by firms around the nation. Laboratory analyses of solidified samples by the ERCO laboratory have pointed to the need for adopting a four-part working disposal concept:

☐ First, wastes must be analyzed to identify the component materials and measure the proportions in which they occur. While most wastes are considered homogeneous — it is not economically feasible to separate toxic from nontoxic components — disposal methods chosen depend on the environment of the toxic fractions. Mercury in a sulfate solution would require a special kind of solidifying technique, in this case perhaps solidifying in a sulfate-resistant portland cement.

☐ Second, if determined necessary by analysis, the wastes might require pretreatment to chemically fix, or stabilize, extremely toxic components, such as mercury or arsenic. Also, the pH of a waste might have to be changed to avoid an acid-base reaction with a particular solidification agent.

☐ Third, the stabilized wastes must then be solidified. Agents of solidification used commercially include asphalt (bitumen), urea-formaldehyde, polybutadiene, lime-pozzolan, portland cement, soil sealant and clay, polyester resins, and inorganic polymers.

☐ Fourth, each step in the disposal procedure must be rigorously tested under conditions simulating the worst conceivable case of environmental attack. One testing technique used by ERCO is elutriation — repeated washings and soakings of processed samples — under various thermal insults. Materials leached from solidified samples are tested for mutagenicity and carcinogenicity to evaluate the effectiveness of the solidification technique.

As our economy grows and increasingly sophisticated industrial processes produce larger quantities of hazardous wastes, and as ever higher standards of disposal safety become legitimized as law, two results can be expected. Not only will the wasteload grow because of expanding productivity, but some materials not considered hazardous at present may suddenly be reclassified as toxic troublemakers. Clearly, the efforts being expended to develop safe, economical disposal techniques come none too soon. — *L.A.P.* ☐

## The Carcinogenic Automobile

A new Swiss study strongly suggests that increased risk of cancer should be added to the balance sheet of pleasure, prosperity, sprawl, and tragedy which the automobile has brought to mankind.

Five years ago three Swiss scientists discovered that the death rate due to cancer between 1958 and 1970 was nine times as great in one section of a small (unnamed) Swiss mountain village as in another. The two sections of the town are separated by a small mountain; a major highway is close to about half the town and is about a quarter-mile away from the other half.

Although they suspected that the localized occurrences of cancer in one part of the town might be linked to the effect of geography upon environmental carcinogens, which were in turn linked to motor vehicle exhaust, they had no data to support or challenge their hypothesis. Now the three workers — the late Mac Blumer, recently at the Woods Hole Oceanographic Institute, Dr. Walter Blumer, a physician practicing in Netstal, Switzerland, and Theodore Rich of the University of Zurich — have completed analyses of soil samples from throughout the village and the mountains around it, soot from car and chimney exhausts, and dust from inside buildings in the town.

They found that automobile exhaust and soils from near the highway contain a series of polycyclic aromatic hydrocarbons (PAH) that are not found in the soot produced by low-temperature combustion — from fuel oil burned in domestic furnaces, for example.

Reporting in *Environmental Science and Technology* for November, the scientists say their data "provide a powerful argument that car exhaust is responsible for the observed PAH accumulation in the Swiss valley." Because PAH are known carcinogens, the authors think their work "strengthens the correlations between highway traffic and the observed mortality from cancer."

"The implications for public health, for city and highway planning, and for efforts to control engine exhaust are considerable," they write. — *J.M.* □

## Power vs. Health in New England

Most of New England's electric power is generated from heavy "residual" fuel oil, and most of that is imported. Both the rising price of oil and federal pressure to reduce U.S. dependence on foreign energy, saving oil for uses where it has special advantages, press on New England utilities to plan for change. Should the conversion be to coal, or should New England take the nuclear option?

Two recent M.I.T. studies claim that a coal dependent New England would mean 20 times as many health problems as a nuclear New England.

Both analyses separate two kinds of hazards: "occupational" are the health effects on employees of the energy industry itself, and "public" are those to which the rest of us are involuntarily exposed.

"Occupational" health effects are simple to analyze because they can be measured directly. According to a summary of data from the Council on Environmental Quality assembled by James Gruhl of the M.I.T. Energy Laboratory, to dig from a shaft (not surface) mine, process, and transport a year's supply of coal for a 1,000-megawatt generating station may cost four lives and 112 injuries, a total of 15,280 working days lost. That compares with 0.23 lives and 335 lost days to produce, refine, and transport nuclear fuel to do the same job, according to a thesis in environmental engineering by Patrick W. Walsh. (The costs to produce oil for a 1,000-megawatt plant are 0.35 lives, 32.3 injuries, and 335 lost days, according to Dr. Gruhl.)

"Public" effects — radioactivity in the case of a normally operating nuclear plant, pollutants from a coal-fired plant — are subtler and harder to analyze, especially in the case of New England.

Sulfur oxides from the combustion of sulfur-laden coal enter the environment as $SO_2$; as it mixes and drifts away, much of this gradually changes into toxic sulfates. Such sulfates are now present in the atmosphere of the eastern U.S. at levels of 16 to 19 micrograms per cubic meter, well below the limits set by the Environmental Protection Agency. But no one can be sure if $SO_2$ released by coal-fired generators in New England would increase this burden. How much of it would drift out to sea before reacting into sulfates? And how much of those might later drift back?

The E.P.A. says the statistical mortality due to $SO_2$ from a well-controlled, coal-fired 1,000-megawatt generator in New England would be less than one person per year. But Mr. Gruhl notes that there may already be "significant sulfate-caused health problems"; if this is the case, increased $SO_2$ would have more serious results.

The other danger from fossil-fuel combustion is particulates — tiny particles of inorganics and organics — of which 2,600 tons come from a well-operated coal-fired 1,000-megawatt generator in a year. This is about twice as much as comes from an oil-fired plant, and the dimensions of this danger are almost wholly unknown.

The organic particulates "are known to be identical or similar in action to carcinogenic components of tobacco smoke," writes Mr. Gruhl, but their effect in the minute concentrations which would result from electric power generation is uncertain. A more likely hazard is the trace quantities of minerals which emerge in respirable-size particles from coal-fired plants. Among them are arsenic, antimony, beryllium, lead, mercury, selenium. These elements are especially abundant in western coals, and "health implications are possible" if western coals are substituted for oil in New England.

The "public" danger from a nuclear plant operating within guidelines of the Nuclear Regulatory Commission is from normal, low-level radiation. Mr. Walsh calculates 0.015 cases of cancer and 0.012 cases of "genetically-linked serious disability" due to such radiation released during one year among people living within a 50-mile radius of a 1,000-megawatt reactor. The low-level emissions within 60 miles of a fuel reprocessing plant may result in 0.005 cases of cancer and 0.004 cases of disability per year per 1,000-megawatt plant. This all adds up to one death every 28 years, writes Mr. Walsh.

Although the studies add some light to the coal-nuclear debate, there are still serious matters of radioactive waste disposal and terrorism to be settled before nuclear power can really forge ahead. The leftovers from a coal plant will certainly not be around for centuries to worry our progeny and nobody has yet discovered how to threaten a city with a lump of coal. — *J.M.* □

STARS AND SPACE

## Gamma Sky

An astronomer must sometimes feel like a librarian working at the bottom of an avalanche of books: each wavelength of the enormous cascade of electromagnetic radiation bombarding earth carries with it some information about the nature of the cosmos.

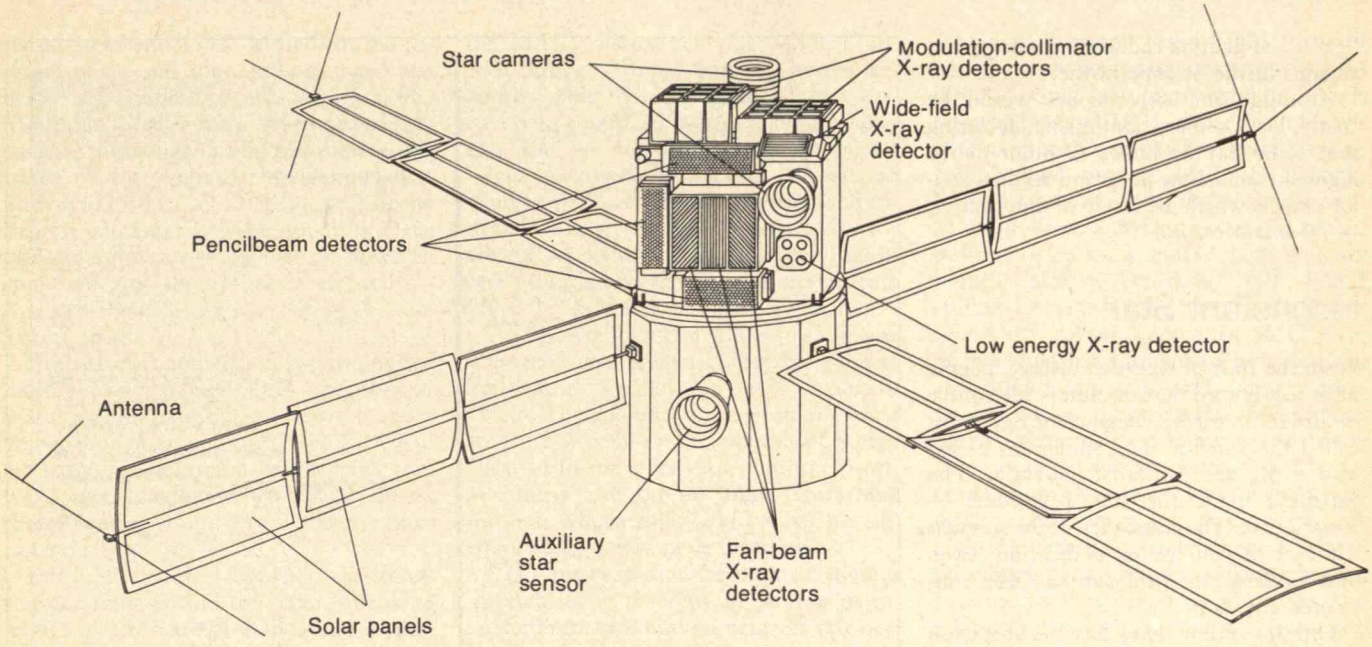
One particularly intriguing "volume" of this cosmic information can be obtained by scanning gamma ray bombardments from space, and scientists at the recent American Physical Society meeting discussed some of their latest findings in this region of the spectrum.

Gamma ray observations are particularly exciting, said D. A. Kniffen of N.A.S.A.'s Goddard Space Flight Center, because the rays penetrate through the dust and gas of interstellar space that absorbs electromagnetic radiation at longer wavelengths. Hence observations are possible in regions previously obscured. High-energy gamma rays are produced in the most energetic processes in the universe, involving energetic cosmic rays, supernovae, pulsars, and possibly black holes.

The catch to gamma ray astronomy is that gamma rays from space cannot be seen from the earth's surface — they are lost amid the confusion of gamma rays created in the atmosphere by cosmic ray bombardment. Thus, the results of gamma ray astronomy presented at the meeting came from data gathered by two orbiting gamma ray observatories — the Second Small Astronomy Satellite (SAS-2) launched in 1972, and the COS-B satellite launched in 1975 by the European Space Agency.

According to Dr. Kniffen, the most striking of these satellite observations was

N.A.S.A's SAS-2 satellite (below) has detected strong gamma radiation emanating from the plane of the Milky Way. It has also found that weak gamma radiation is unexplainedly widespread throughout space.




the very bright gamma ray emissions from the plane of the Milky Way. Because gamma rays are produced when cosmic rays collide with atoms or molecules in space, they should come from areas of high matter or cosmic ray density.

So far, gamma ray observations have indicated that the cosmic rays that produced them are galactic, and confined to areas fairly close to the disk of our galaxy. There is also evidence that the rays are more abundant where the matter density in the galaxy is higher.

According to Dr. Kniffen, the first point-like source of gamma rays to be seen was the Crab Nebula, which also contains the fastest radio pulsar known. Gamma ray observations have also been correlated with other pulsars and x-ray sources. Such correlations will lead astronomers to a much better understanding of the processes going on within these important celestial objects. SAS-2 data has also shown that there is a diffuse gamma radiation coming from throughout the sky, although the source of this radiation is still mysterious.

The clues to the structure of our galaxy that may be offered by gamma ray observations were discussed by Floyd W. Stecker of N.A.S.A./Goddard. According to Dr. Stecker, gamma ray observations and radio telescope observations have determined that the regions of most active star formation and cosmic ray production lie about halfway between our sun and the center of the galaxy. The cosmic ray production maximum forms a ring around the center of the galaxy about 15,000 to 20,000 light years from its center, which Dr. Stecker terms a "cosmic ray bagel." Interestingly, this distribution of cosmic rays coincides with the region of highest supernova remnants and pulsars, which are thought to result from supernovae. Such discoveries have shown that cosmic rays are not primarily extragalactic in origin, but originate within the galaxy.

Preliminary gamma ray observations from the European Space Agency's COS-B satellite were reported by Italian astronomer Giovanni F. Bignami at the Physical Society meeting. In the months since its August 8, 1975, launch, the satellite's highly directional gamma ray detector has discovered several new gamma ray sources in the Gemini-Taurus, Perseus and Cygnus regions of the sky. "The most intriguing feature about these new sources is certainly that they cannot yet be correlated to any known celestial object, in spite of various searches having been carried out," said Dr. Bignami.

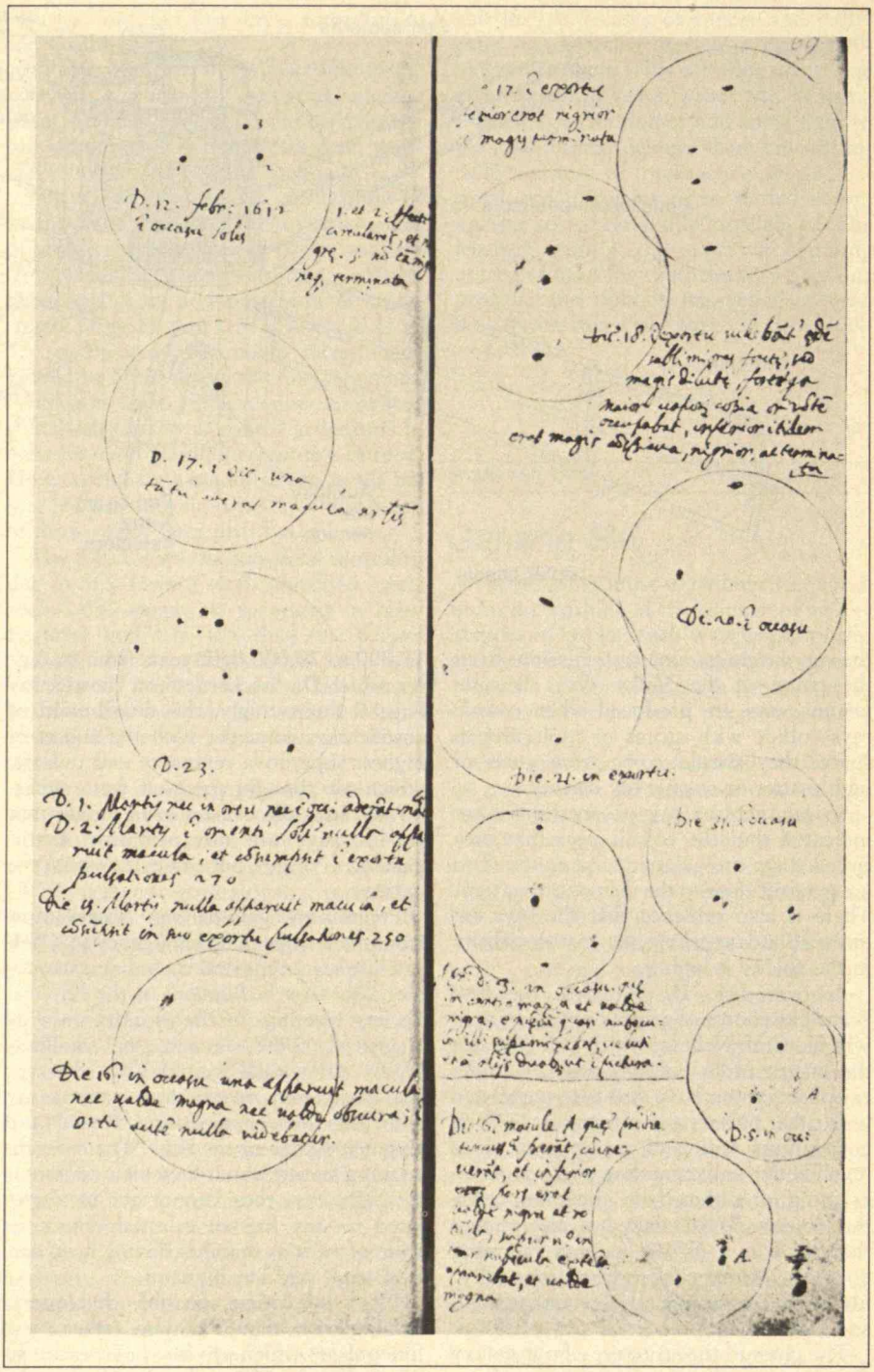
"It is, of course, possible that one is dealing with known gamma ray emitters like pulsars which are for some reason so far undiscovered in other bands, but the exciting possibility also exists that we are slowly coming up with representatives of a totally new class of celestial entities — a situation reminiscent of the black holes discovery from the evidence of the first galactic x-ray sources."

It may even be possible to use gamma ray detection to distinguish matter from anti-matter for the first time, said John G. Cramer of the University of Washington. The science-fictionish anti-matter, say physicists, is the electrical inverse of normal matter, with positively charged electrons circling a negatively charged nucleus. Although anti-matter has been produced in only minute amounts in particle accelerators, physicists theorize that huge quantities, perhaps entire galaxies, of anti-matter may exist in other parts of the universe.

In most respects, matter and anti-matter stars are completely indistinguishable, but Dr. Cramer proposed at the Physical Society meeting that the circular polarization of gamma rays emitted by anti-matter stars may be different from that of matter stars. "It is as if the rifle barrels that shoot radiation to us from matter and anti-matter have opposite riflings, and spin their bullets in opposite directions," he said.

Drs. Cramer and Wilfred J. Braithwaite of the University of Texas found that the "beta decay process" which plays a role in a star's nuclear fusion reactions may provide the means for distinguishing matter from anti-matter stars. This process gives rise to electrons or positrons, depending on whether the star is matter or anti-matter. When these particles slow in their movement through space they will produce gamma radiation of opposite polarizations. Detection of this polarization may not be possible in normal stars, said Dr. Cramer, but only in the violent explosions of novae or supernovae.

Dr. Cramer proposed that "gamma ray circular polarimeters" could be placed in orbit by the Space Shuttle to detect the



Sunspot drawings such as these made by Galileo give archaeoastronomers a way to study the sun's past history. By monitoring the changing sunspots, they can monitor any changes in rotation rate of the sun. (Photo: N.C.A.R.)

"twist" of gamma radiation coming from various novae or supernovae.

Although the experiments would be costly, Dr. Cramer is optimistic, declaring that some day he hopes to point to the night sky and show his grandchildren stellar objects which are made of anti-matter. — *Dennis Meredith* □

## Inconstant Star

From the start of recorded history, people have recognized that the sun is the source of all life on earth. The ancient Egyptians called the sun Ra. The Sumerians called him Utu; the Indians, Garuda. The Japanese made the sun a goddess — Amarterasu. The constancy of the sun was a major reason for its deification. Even into modern times, the sun has been considered constant.

Only in recent times has the suspicion grown that our "constant" sun may indeed not be; the luminosity or energy that it sends our way may vary as much as 1 or 2 per cent. And this small difference has substantial impact upon the earth. Experts estimate that during the last ice age that buried much of the world under glaciers, the global temperature changed only a few degrees.

The sun's inconstancy can be read in the records of solar activity left in the carbon-14 content of tree rings. Tree ring records represent a surrogate measure of the solar activity that blocks some of the cosmic rays that produce carbon-14 in the earth's atmosphere. The lower the solar activity, the more carbon-14 is available to find its way into living things. Thus, the tree rings can be correlated with both solar activity and historical time.

Jack Eddy, astronomer at the High Altitude Observatory in Boulder, Colo., uses such tree ring records to trace solar activity. The oldest living trees, bristlecone pines, are 5,000 years old. These living records can be extended back yet another two millenia through the study of well preserved wood. From these studies, Dr. Eddy concludes, "Only recently have we come to appreciate that our sun is unusually well behaved just now. There have been many times since the Bronze Age when it was not so well behaved, and when life on earth has suffered as a result."

Some indications are that this period of good behavior may be ending. Robert Howard, astronomer at the Hale Observatory in California, reports that since 1967 the sun has been gradually spinning faster on its axis. Using Mt. Wilson's 150-foot tower telescope to observe magnetic fields and motions of the solar gas, he concludes that the acceleration of the solar surface is greatest 10 to 15 degrees each side of the equator, rather than at the equator itself. Areas near the solar equator are now rotating as much as a day faster than their "usual" 27-day rotation.

A similar change in rotation can be inferred from historical records of a very unusual time in the past, the so-called "Little Ice Age," when Europe was gripped by piercing cold, the Danes abandoned their Greenland colonies, and the Thames River froze with regularity for winter carnivals. Dr. Eddy finds that climate was not the only thing different for some of that time.

Sunspots and other signs of solar activity all but vanished for the 70 years be-

tween 1645 and 1715. Moreover, the rotation of the sun apparently changed just before the spotless period, known as the Maunder Minimum, set in. Studying sunspot drawings made just before the onset of the Maunder Minimum, Dr. Eddy and his H.A.O. colleagues, Dorothy Trotter and Peter Gilman, found that the sun's rotation rate — or, the rate at which spots on the sun's surface rotated — changed significantly just before the sun lost its spots.

Even as astronomers are confirming the unusual past behavior of the sun, other researchers are finding that the sun is again going through an unusual 11-year cycle of activity. The minimum of sunspots that was reached in late 1974 lasted almost three years. Only very recently have sunspots begun to return.

Dr. Eddy believes that the near-record sunspot minima and the record-breaking winter of 1977 are probably only a coincidence. Explaining that there is still too much uncertainty about the past climate record to allow an absolute correlation between climate and sunspots, Dr. Eddy nonetheless concludes that, in view of the "coincidence" of the Maunder Minimum and the Little Ice Age, the current coincidence is at the very least provocative. — *Joann Temple Dennett* □

## One Million Suns in 60 Seconds

A quiescent spot in the sky suddenly bursts into activity, the source of invisible x-ray radiation with the power of perhaps as many as a million suns. Less than a minute later the sky is quiet again.

This is the "x-ray burster," the newest riddle from the oldest science. Countless sources of x-ray radiation have been found since x-ray astronomy became an active branch of science in the 1950s. But nothing in this growing experience prepared astronomers for the report from Russia in 1975. Cosmos satellites had detected mysterious bursts of x-rays which reached their maximum strength in less than 1 second and decayed within 60 from the vicinity of the galactic center. Dutch astronomers confirmed the Russian observations, and the M.I.T. X-ray Astronomy Group also turned its orbiting x-ray observatory aboard the SAS-3 satellite toward the x-ray source.

In the last year, George W. Clark and Walter H. G. Lewin and their colleagues found 11 more "x-ray bursters." Eight others have also been discovered. Among the M.I.T. discoveries was MXB 1730-335, dubbed "Rapid Burster" by the scientists. This, the strangest of their discoveries, produced x-rays like machine-gun fire — very energetic, 50-second bursts followed by longer, 400-second waiting periods. The Rapid Burster produced as many as 1,000 bursts a day for several weeks, and then, suddenly, nothing: no radiation has been observed from MXB 1730-335 since April, 1976.

All known "bursters" seem to share one important characteristic: they behave like "relaxation oscillators," says Professor Lewin. The amount of energy in any burst seems to depend on the amount of energy left over in some reservoir after the previous burst and on the time intervening through which additional energy has accumulated in that same reservoir.

They propose that the bursts represent instabilities in the flow of plasma or interstellar material into a neutron star or a black hole; other astronomers suggest a source in nuclear explosions on the surface of a neutron star, and still others are tempted by concepts involving exotic supermassive black holes. Whatever they represent, x-ray burst sources are now being discovered at the rate of about two a month, and a worldwide program of "burster" observations is underway, in which astronomers everywhere are turning their instruments on six "burst" sources selected by SAS-3. With such simultaneous observations in many frequencies and parts of the world, and with "a little luck" says Professor Lewin, "a new piece of the puzzle could be put in place" at any moment. — *J.M.* □

## Reckoning the Mass of a Neutron Star

Though the postulated characteristics of neutron stars are highly exotic — invisible, only ten miles in diameter but with more mass than our sun, and with a density of about 10 billion tons per cubic inch — most astronomers are convinced of their existence.

According to today's theories of stellar evolution, a neutron star is formed when the core of a star more than about four times the mass of the sun collapses. (A smaller star avoids collapse by slowly shedding its outer layers.) Most of the mass of the collapsing star is expelled in that tremendous explosion; the resulting neutron star is limited in theory to less than 2.7 solar masses and is considered likely to weigh close to 1.4 solar masses.

Saul A. Rappaport and Paul C. Joss of M.I.T., with new data from the M.I.T.-directed x-ray astronomy satellite SAS-3, launched May, 1975, have found indications that this theory is correct.

Only two months after the launch, SAS-3 reported that the x-ray source 3U0900-40 was in fact not constant but pulsing — an x-ray pulsar. Less than six months later, in February, 1976, SAS-3 studied closely, for the first time, another new x-ray pulsar known as SMC X-1. Such a pulsar is thought to be a neutron star spinning in orbit with a binary companion star — somewhat like the two cups of an anemometer. Matter is constantly being dumped on the neutron star by its companion; this matter is funneled to the neutron star's magnetic poles, where its collision with the surface of the star produces two beams of x-rays. These beams, rotating as the neutron star rotates, are seen as pulses by a stationary observer on earth, just as an observer sees only a burst of light as the continuous beam of a lighthouse passes him.

Twelve such x-ray pulsars have been discovered to date, but it has been possible to observe only four of them carefully enough to learn anything about their masses. The observations of 3U0900-40 and SMC X-1 with SAS-3 were important; these two sources have bright, easily observable companion stars, which made possible a relatively precise calculation of the masses of the neutron stars. This is done by a simple Newtonian two-body analysis, based on the radial velocity of each star in the pair and the orbital period of the pair. The radial velocity of the neutron star is determined from Doppler-like variations in its pulse rate, and that of the optical companion from spectroscopic measurements of the Doppler shift; the orbital period of the pair is revealed by the Doppler shifts and by interruptions of the pulsar occurring when the visible star eclipses the neutron star as seen from earth.

The result was that the new pulsar 3U0900-40 was found to weigh between 1.2 and 2.4 solar masses, and SMC X-1 between 0.8 and 1.8. The uncertainties result from imprecisions in the spectroscopic observations of the companion stars.

Data from two other x-ray pulsars and one radio pulsar known to be in a binary stellar system show the five masses to intersect in the range of 1.4 to 1.8 solar masses, well in line with theoretical projections. It's the first "coherent picture" of neutron star masses, says Professor Joss. — *Rick Bauer* □

The venerable trolley car — now fashionably renamed *light rail transport* — may once again be the best means for reaching the heart of a city: This car connects Pittsburgh with its older suburbs. (Photo: U.S.D.O.T.)

TRANSPORTATION

# The Chameleon of Urban Transport

The ranks of the trolley buffs were augmented by a good many serious urban transportation experts in Boston at the end of last summer for a conference on "light rail" transit, sponsored by the Transportation Research Board, the Urban Mass Transit Administration, and the American Public Transit Association. It was immediately obvious that the old-fashioned street car — in the modern guise of a U.S. "standard light rail vehicle" (S.L.R.V.) — may be on the edge of a come-back.

Over 44,000 miles of electric rail transit lines were operated in the U.S. in 1917. Then came automobiles, buses, bigger streets, and good highways, and "street cars" now run in only eight U.S. cities. But 18 other U.S. cities are now talking seriously about adding street car systems: "light rail" cars are running in Toronto; a system is under construction in Edmonton; and Vancouver, Calgary, and Winnepeg are making plans.

But why return to street cars now?

In the spectrum of urban transit alternatives, "light rail" stands mostly in the middle — between "heavy rail" subways at the one end and buses at the other. "Light rail" can be a chameleon — one minute a street car, stopping at every corner, and two blocks later an express train running in its own right-of-way, even in a subway. Typical "light rail" vehicles are built to stop and start quickly (the new S.L.R.V.s decelerate at 5 ft. per second and accelerate at 4 ft. per second), receive passengers from ground level or elevated platforms, run at moderately high speeds (up to 50 m.p.h.), and operate on hilly roadbeds (the S.L.R.V. tolerates grades up to 9 per cent). Depending on the desired speed of operation, street crossings can be on-grade or separated; average speeds on "light rail" systems now in operation in the U.S. range from 10 to 23 m.p.h. Clearly, this makes a "light rail" system far more flexible, and far less expensive, than conventional "heavy rail" rapid transit. Indeed, "light rail" advocates claim that San Francisco's BART and Washington's METRO are the product of an "edifice complex" which dictates construction of the most elaborate and costly project which is fundable.

What of buses, the ubiquitous, ever-flexible solution chosen for most of today's urban transit needs? "Light rail" advocates include buses as feeders and distributors in their systems. But freeways — to which buses are tied in high-speed service — are likely to be circumferential, while a transit network is likely to emphasize radial lines. Indeed, on a well-planned transit system "every rapid transit line should connect with every other line, so any trip through the system can be made with only one transfer," Gerald D. Fox of DeLeuw, Cather and Co., told the "light rail" transit conference.

DeLeuw, Cather and Co. has applied its ideas about "light rail" transit to the problem of Santa Clara County, Calif., whose Transit District has set a goal of supplying 30 per cent of the region's daily trips by 1990, when the population will be 1.5 million: Santa Clara has one of the fastest projected growth rates in the U.S. Will it be done with buses on highways, buses on busways, or "light rail" vehicles on surface tracks?

If it opts for "light rail," Santa Clara County will need a fleet of 45 vehicles like today's S.L.R.V.s (175 passengers — 68 seated, 107 standing), traveling between 2.7 and 3 million miles a year. The annual operating and maintenance costs will be $5.5 to $6 million, of which the fare boxes might contribute about $3 million. If Santa Clara County chose smaller L.R.V.s (85 passengers), 75 cars would be needed; speeds would be 20 per cent lower, passenger demand 14 per cent less, annual operating cost 6 per cent higher, and revenues only $2.43 million, according to figures read by Walter Kudlick of DeLeuw, Cather at the "light rail" conference.

Compared with buses, which are Santa Clara County's other option, "light rail" is expensive to build but cheap to operate. According to Mr. Kudlick's figures, the capital cost of "light rail" would be 11 cents per 1990-passenger-mile, the capital cost of buses operating on streets 5 cents and on busways 9 cents per 1990-passenger-mile. Operating and maintenance costs would be 20, 25, and 22 cents, respectively, per passenger-mile in 1990. Conventional buses would be used for 34.3 million trips, "light rail" for 45.8 million.

Using "light rail" as the chameleon of transit — flexible and changeable — Santa Clara County can begin with the simplest of surface systems and gradually convert some or all of its routes to higher-speed, higher-density operations by building station platforms and grade crossing separations; and feeder lines can be developed and similarly upgraded to serve developing areas. The only unanswered question is what happens if Santa Clara County's guesses are grossly wrong — if growth doesn't come or if it comes in a way to render obsolete the routes of its first "light rail" construction; even a chameleon cannot change its tracks. — *J.M.* □

## Bridge Designers Lose Their Bearings

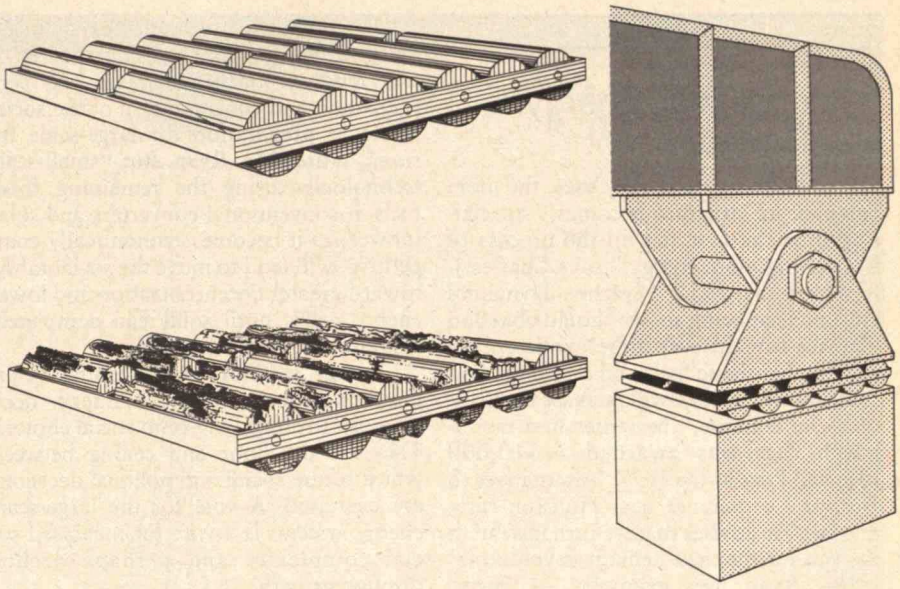
One aspect of bridge maintenance — painting — is an eminently photogenic exercise that appears in the press from time to time. But who gets excited by the binding and freezing of steel-on-steel bridge bearings, even when they sandwich lead plate inserts? Whose eyes soar skyward to scan self-lubricating bronze plates with graphite inserts, or polytetrafluorethylene blocks sliding on smooth stainless steel? Even roller bearings and roller nests — assemblages of several individual rollers harmoniously working together to support steel structures weighing hundreds of tons — have failed to receive their full share of attention.

Bearings relieve stresses produced by temperature changes, winds, and changing soil pressures by providing slippage between the bridge and its supports. Bridge designers are past masters at calculating these movements, and specifying the installation of suitable bearings at just the right points.

But bridge bearings wear out, mainly because of dirt, reports the National Cooperative Highway Research Program (N.C.H.R.P.). In a new publication, "Bridge Bearings," the N.C.H.R.P. — a research arm of the Transportation Research Board — writes that maintenance personnel deal with bearing problems only as they become too obvious to ignore, and recommends, "The designer must take the initiative and ask maintenance employees about bearing problems."

The Transportation Research Board also recommends that designers avoid the whole maintenance problem by avoiding sliding bearings in new designs. It urges the cooperation of designers and maintenance people to keep existing bridges in good working condition. Where sliding bearings are unavoidable in new designs, provision should be made for jacking up the structures to make bearings accessible for easy repair.

Maintenance-free means do exist for taking up bridge movements. For example, some expansion and contraction can be absorbed within a properly designed bridge structure, and large shifts of up to three inches can be absorbed in flexible blocks called elastomeric bearings. Often made of high-quality neoprene, these pliant cushions come close to being the perfect solution to the bearing problem, because they have no moving parts to freeze, nothing to corrode, and therefore eliminate maintenance altogether.



New steel roller bearing nests (top left) in a typical application (right) under a bridge support, invite corrosion and dirt. Several years of exposure without proper maintenance can cause bearings to fail (bottom left), causing the bridge to distort as temperature changes. The trend now is to substitute flexible blocks for problem-prone bearings.

While the maintenance question may eventually be suspended altogether by a new generation of bridges that will need nothing but an occasional coat of paint, today's sliding-bearing bridges will need attention for years to come. While existing spans bridge many of today's gaps, programs for keeping them in tolerable shape still fall short of their mark. — *L.A.P.* □

## No Offshore L.N.G. Ports

On an average day, receiving terminals in the ports of Boston (Everett, Mass.), New York (Staten Island), Providence, Baltimore (Cove Point), and Savannah (Elba Island) take in a total of some 55 million cubic feet of liquefied natural gas (L.N.G.). This intake represents only 3 per cent of the world's L.N.G. commerce.

Within three years, as domestic gas resources dwindle, U.S. demand for foreign L.N.G. will increase sharply. Imports may soar to as much as 1.8 billion cubic feet a day, perhaps 30 per cent of world L.N.G. trade, by 1980. Frost and Sullivan, Inc., market research specialists, think today's $758-million-worth of L.N.G. in international trade may grow to $7.9 billion by 1985.

Offshore, deep-water receiving terminals would handle this prodigious increase with less risk to populated areas and offer economies of scale by making possible larger L.N.G. carriers, say Henry S. Marcus and John H. Larson of the M.I.T. Department of Ocean Engineering. But, they add, all signs point to continued reliance on conventional portside facilities.

We're simply not yet ready to build and operate offshore facilities and the giant L.N.G. tankers to service them. Technologies for both ships and facilities are unproved and environmental impacts have yet to be studied. For example, an offshore terminal using seawater to carry away the cold from vaporizing liquefied gas would need biocides to keep seawater tubes clear of marine encrustation. But no one knows how harmful such biocides might be to the marine ecology nearby. Neither are regulatory processes formulated, nor are prices predictable.

Only by the 1990s can these uncertainties be resolved, Professor Marcus and Mr. Larson told members of the Society of Naval Architects and Marine Engineers in San Francisco last May. Perhaps by the year 2000 natural gas handling can be concentrated offshore, where it seems to belong. When that day comes, the change will be driven more by environmental and safety reasons than by economics. — *J.M.* □

ENERGY

## Moderation in Energy — and Society

The more energy a society uses, the more complex its structure becomes. "Specialization is the first step in the process of controlling more energy," says Charles J. Ryan of the M.I.T. Systems Dynamics Group. That being so, we should abandon the race toward ever more exotic energy sources. Synthetic fuels and breeder fusion reactors and the like will increase the "risk of social collapse," he writes in a monograph that was awarded a $10,000 Mitchell Prize at the 1977 "Alternatives to Growth" conference near Houston early this fall. He advises that we turn instead to the sun for the next "energy revolution."

Mr. Ryan uses examples — Egypt, Rome and Britain — to support his thesis:

Since history began, growth in the production and consumption of energy has been tied to growth in the infrastructure — and therefore in the complications — of society. Energy was kept in balance in early Egypt by the conservative religious values of the ruling Pharaohs; the ruling class was small and consumed little wealth because a chief religious objective was to take wealth into the tomb. During the process of imperial expansion, ancient Rome fell because energy demand was concentrated at the center of the Empire. Provinces could not — or would not — meet the demand; the result was social pressure, which ultimately led to civil war and barbarian invasion. Britain, first isolated and necessarily self-sufficient, began the process of growth with the sailing ship —a significant, incremental energy use. One thousand years later came the industrial revolution, triggered by wood- and coal-fired steam engines. British society has since become ever more complex and the nation more prosperous — at least until the current century.

Now we enter a period characterized by the depletion of fossil fuels and a new set of economic, political, and military pressures. The world must make a profound choice between two paths, says Mr. Ryan. We can proceed on our present course of ever-greater energy consumption and ever-more-complex social interdependencies and structures, and risk great economic and political upheaval if we fail to achieve the ultimate goal of fusion. Or we can renounce such exotic and dangerous technologies as fission and fusion, and turn instead toward an energy source which is constant and ubiquitous: the sun.

"The large-scale technologies — fission and coal gasification and liquefaction — will tend to further increase the centralization and concentration of the social fabric in preparation for large-scale fusion," writes Mr. Ryan. But "small-scale technologies using the remaining fossil fuels in conventional converters and solar [power] as it becomes economically competitive, will tend to move the social fabric toward greater decentralization and lower energy needs until solar can completely support the social structure.

"Energy systems are influential determinants of social structure. Energy decisions are in effect long-term social choices. They set the floor and ceiling between which future social and political decisions are exercised. A vote for the large-scale energy systems is a vote for increased social complexity and perhaps decline through growth.

"Dependence on solar energy sources can create a future that is harmonious with the institutions, traditions, and values that have brought humanity down a million-year path." — *J.M.* □

## Retrieving Hydrogen Photochemically

Measured atom by atom, hydrogen is one of the most ubiquitous elements on earth, second only to oxygen. Were it freely abundant as the diatomic molecule $H_2$, it would easily spell off any energy shortfall. But hydrogen is a gregarious element, found most often in combination with other elements. The task of forming $H_2$ by separating hydrogen atoms from their companion oxygen atoms in water, $H_2O$, and performing this feat without overspending energy, is now a paramount challenge to chemistry.

One approach is to utilize sunlight as the energy source in photochemically splitting $H_2O$ into $H_2$ and $O_2$. The trick is to use sunlight to activate catalysts which divide $H_2O$ into the gaseous $H_2$ and $O_2$. A useful system should employ catalysts that undergo no net chemical changes.

Chemists from the California Institute of Technology announced at the annual meeting of the American Chemical Society this fall that they've taken the first step in this journey. They've found a chemical compound that, when mixed with $H_2O$ and exposed to sunlight, stimulates the release of some molecules of $H_2$ gas.

The system is inefficient, releasing only about four molecules of $H_2$ for every 100 photons of light, and it uses only the visible spectrum of light. More importantly, no method has yet been envisaged to recover the oxidized catalyst in its pure form. Yet the step is important. Harry B. Gray, Kent R. Mann, and Nathan Lewis are the first chemists to contrive a catalyst that releases electrons by pairs. Previous similar efforts enabled the release of only a single electron.

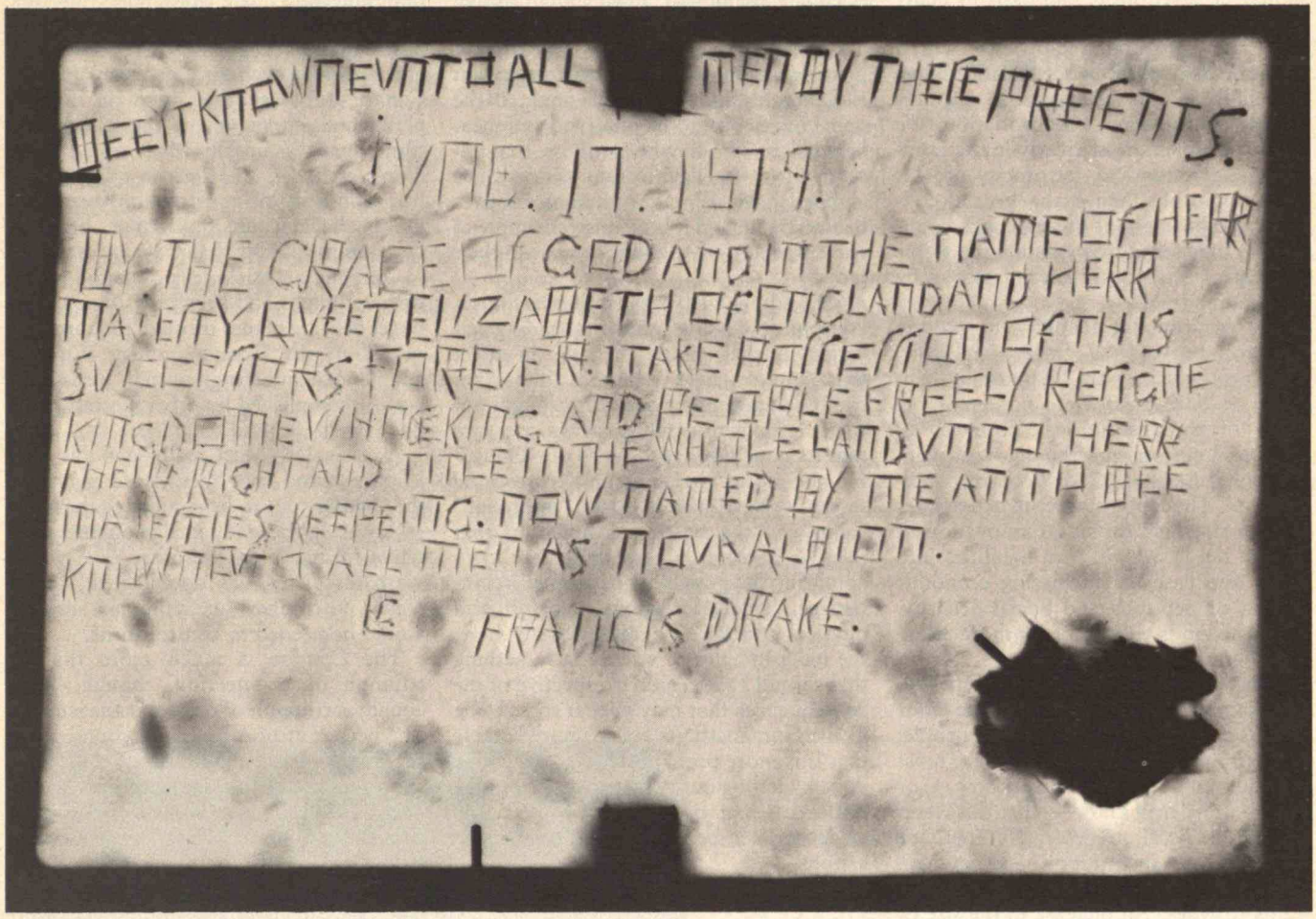
The catalyst is a molecule containing two rhodium atoms linked by four "ligands," bridges of carbon, nitrogen and hydrogen atoms that hold two rhodium atoms closely enough so that they can interact. Because of the ligand clamp, rhodium releases electrons in pairs. These electron pairs combine with the hydrogen contained in molecules of $H_2O$. Molecules of $H_2$ are thus released.

The reaction works like this: rhodium (Rh) atoms, joined by the ligands, are mixed with $H_2O$, turning the $H_2O$ a deep midnight blue. When sunlight shines on the solution, the Rh is activated and releases a pair of electrons. The electrons are deposited on two hydrogen ions, to couple and form a hydrogen molecule. The solution has now turned a pale yellow; what's left is hydroxide and the oxidized form of the rhodium complex.

Now the chemists are concentrating their research on changing the composition of the ligands in order to alter the distance between the two Rh atoms. Using various ligands, the color of the working solution shades the spectrum between blue and yellow, and the characteristics of the reaction can be controlled.

Even with the hydrogen removed, the reaction is not complete until the oxygen is removed as well. That is, the oxidized form of the rhodium complex must be sunlight activated to evolve $O_2$ from the hydroxide, simultaneously regenerating the original blue rhodium species. Mark Wrighton, Professor of Chemistry at M.I.T., is now experimenting with the second half of the reaction. His research is, he says, in its infancy.

That rhodium will eventually be used to commercially convert $H_2O$ into $H_2$ and $O_2$ gas is by no means a foregone conclusion. Energy economics dictate that the two reactions (hydrogen and oxygen removal) use less energy than the equivalent of 1.23 volts — the energy required for electrolysis of water. Photochemistry of this kind is now so new that chemists, Dr. Wrighton included, decline even to hazard an opinion on commercial possibilities. As a strong beginning, however, the experiment stands out as what Dr. Wrighton calls "a fundamental advance of some consequence." — *S.J.N.* □




In 1628 Francis Fletcher, who was Chaplain aboard Sir Francis Drake's *Golden Hind* almost 50 years earlier, wrote of the installation of "a plate of brasse . . . whereon is engrauen her graces name, and the day and yeare of our arriuall there, and of the free giuing vp, of the prouince and kingdome, both by the king and people, into her maiesties hands . . ." This plate was found in 1936, but recent research suggests that it is probably a forgery.

SLEUTHING

## "Plate of Brass" a Hoax

Did Sir Francis Drake really leave this memento — the famous Plate of Brass — of a visit to San Francisco Bay in 1579?

Probably not. Almost surely, it's a fake.

The plate in the picture was found in Marin County, near the Bay, in 1936, and since then it's been a magnet for skeptics at the University of California's Bancroft Library in Berkeley.

Reports by two metallurgists at Columbia University and Professor George R. Harrison, then in charge of the Spectroscopy Laboratory at M.I.T., tended to dispel early doubts. But uncertainties remained, so James D. Hart, Director of the Library, sought a new series of tests early in this decade.

Experts from the Folger Memorial Library turned out to be critical of both letter forms and spelling used on the Plate of Brass, and they speculated that the quality of the engraving was below that expected of artisans who must have been represented on Drake's expedition for ship and gunnery repairs.

Metallurgists at Oxford University, using X-ray fluorescence, showed the plate to contain 34.8 per cent zinc and 61.2 per cent copper, 120 parts per million of silver and 500 parts per million of tin, and over 0.05 per cent lead. In contrast, brasses known to have been made about 1600 in general had zinc content of less than 30 per cent, lead content much greater than 0.05 per cent.

Neutron activation testing at the Lawrence Berkeley Laboratory confirmed the Oxford analysis, and the California metallurgists added that the distribution of elements by weight matched closely that in a modern sheet brass alloy known as number 268.

Even before these analyses were completed, the Bancroft Library had called "the outstanding authority on the history of metallurgy," Cyril S. Smith, Professor Emeritus at M.I.T., to join the study. He in turn joined the chorus of skeptics: "All of the features that I have noted make me incline to the opinion that the plate is a modern forgery."

The corrosion seemed "superficial" and inconsistent with a 400-year exposure to the elements, he wrote; the plate seemed to be more uniform in thickness than could have been achieved by 16th-century artisans; and the edge of the plate seemed to have been sheared (and camouflaged by hammering) — it did not show the "chisel-cut-and-filed edge that one would expect on a 16th-century plate."

Professor Smith noted that ancient sheet metal was created by hammers, leaving the metal grains oriented randomly, whereas modern rolling processes leave the grains oriented in the direction of the rolling; and he suggested diffraction studies to determine the presence or absence of a preferred orientation.

That research has now been done, and Dr. Hart admits in a report published during the summer that the evidence is now "essentially negative." — *J.M.* □

## Boulding

*Continued from p. 4*

the replacement of status with contract is an important goal for liberation movements of all kinds, particularly where status is inferior. Nevertheless, contracts should be given more emphasis in many areas of life — particularly the labor market. The informal reciprocity which characterizes many labor relationships, especially in the professions, requires flexible instruments of renegotiation. We see this problem most clearly in the family, where status and reciprocity are far more important than exchange and contract; the business of the marriage counselor is precisely to renegotiate the terms of reciprocity so often misunderstood by husband and wife.

The institutional inability to modify contracts provokes a great social cost. Contracts which could be mutually beneficial to both parties are not made because of the institutional obstacles of habit and custom and the absence of institutional facilitators, or "contract middlemen." The labor market in active later life is a ripe field for social innovation. If we can tap it we will turn liabilities into assets and ease the increasing economic burden of pensions and Social Security. The problem is worthy of far more attention than it now receives.

Some illusions must first be dispelled. For example, many claim that if the labor force is expanded to include older people, women, or minority groups, others must lose their jobs. All economists know — or at least think they know — that this claim is false: the fiscal, monetary, and perhaps the price-wage institutions of society can be so organized as to absorb anybody who wants to work. An increase in the size of the voluntary labor force should be almost pure gain to society, though it may involve some redistribution, and a few people may be relatively worse off as a result. But the gain to society is so great that even those who are relatively worse off are likely to be better off in absolute terms.

Discretion is the only answer to discrimination. It may be difficult but it is surely a skill that can be learned and bolstered by new institutions. To rely on arbitrary rules rather than on our wit, imagination, and judgment is sheer cowardice. □

## Cowen

*Continued from p. 7*

extent to which mental ability is genetically determined is another. Indeed, the latter question is so fraught with emotion that scientists who try to pursue it are often publicly vilified and denied the right to speak.

Sir Andrew Huxley, in his address as President of the British Association for the Advancement of Science, warned against this kind of intellectual repression last summer. The editor of *Nature,* among others, immediately took him to task saying: "Freedom for scientists to investigate whatever they want may be a valid rallying point in some circumstances. . . . But scientists are already under some external constraints on their freedom, for ethical and financial reasons, and it is clearly not possible simply to say that everything that is observable and measurable ought, in the name of science, to be observed and measured. . . . Those who propose that research [on intelligence and genetics] be stopped have some very human motives behind them, and it is no answer simply to wave freedom of scientific inquiry in their faces."

Sir Andrew tartly replied that he finds it "deeply depressing" that the leading scientific journal should "tell us, in effect that, in any field which is important enough to generate emotion, we ought not to undertake research until we are sure that its conclusion will be to our liking." He also noted that pressures to stop the research have taken such "improper" forms as "the baseless insinuation that there is necessarily something 'racist' in admitting the possibility of a genetic component; denial of freedom of speech; and physical attacks." He adds, "In my view, the independence of science is something that should be accepted irrespective of the consequences that may appear to us to be likely. Human affairs are so unpredictable that it is more probable that good will be done by letting our beliefs follow from the evidence, than by deciding without the evidence what beliefs will lead to the best actions." □

## Meredith

*Continued from p. 9*

bowsprit was handy to hang it on — the *Gossamer Condor* was ready to fly.

And fly it did. Over a period of 12 months the *Condor* logged over 400 flights — as many as all other man-powered planes in history combined. A dozen different versions of the plane were made, each one coming closer to the prizewinner.

Art quickly took over from science in the testing: "After a bunch of flights, if a part didn't break, we made it thinner the next time around," said Dr. MacCready. So minimized was the plane's structure that when one slightly overweight pilot tried to get the plane off the ground, it collapsed into a shimmering mass of Mylar, wire, and aluminum.

The crashes, in fact, were magnificent. A stray breeze, an approaching cropduster, or a broken support wire would send the delicate craft crumpling to earth like a broken spider web. Time after time the *Condor* collapsed, only to spring to life again with a little help from its friends. Repairs that would have required months for the *Condor*'s more intricate cousins were made in hours or days because of the plane's simplicity.

The many other aeronauts vying for the Kremer prize had tried to build planes that flew gracefully; Dr. MacCready and his cohorts had built a plane that would crash gracefully. Mishaps that had meant the end for other such aircraft meant for the *Condor* only "another point on the experimental curve where the plane just came apart," said Dr. MacCready. "We didn't realize at the time how important [the simplicity of construction] was, but looking back, it sure looked like a brilliant decision to build it that way."

One major sticking point for man-powered flight had been how to coax the huge, delicate planes through the turns required in the Kremer course. While a couple of lumbering, partial turns had been accomplished by other aircraft, they had hardly inspired confidence.

In tests Dr. MacCready and his colleagues found that they could persuade the *Condor* to turn by contorting the wing — lowering the leading edge on one wing while raising it on the other. The wing-warp discovery was double luck, for it meant no cumbersome, complex ailerons would be needed to control turns.

The *Condor* is much more than a triumph of engineering, though; it is equally a triumph of project management. The perfect airport had to be found: near the group's Pasadena headquarters, away from mountains, blessed with light winds and a 100-ft. hangar. Some diligent work turned up Shafter Airport, near Bakersfield, Calif.

The ideal pilot was also needed — a light, strong, championship bicyclist who was also a good pilot. A few phone calls put the engineers onto Bryan Allen, a slim 24-year-old who flies hang gliders and can generate almost half a horsepower for the seven minutes required to complete the course.

Some of the procurement needs were more unusual: "the best toy fire engine wheels that money could buy" were needed to support the *Condor* on its short take-off runs.

### Grandparents in Flight

The *Gossamer Condor* will probably hang in the Smithsonian Institution, alongside its pioneering brethren *The Spirit of St. Louis* and the Wright brother's plane. And although Dr. MacCready plans no major man-powered airplane adventures beyond building a better *Condor* to fiddle with, he foresees great things ahead for the future Icaruses.

Plans for the *Condor* will be available soon, and it should prove a popular toy. Because of its slow speed and easy handling characteristics, just about anybody can fly the plane, which Dr. MacCready dubs a "docile behemoth." He boasts that

the plane responds so slowly that a novice finding himself in aeronautical trouble has time to peruse the instruction book before yanking the control stick.

A dozen or so people — pilots and nonpilots, male and female (including one grandmother) — have flown the plane since its historic flight. Dr. MacCready predicts that in the plane's next edition he will be able to lop 25 per cent off the power requirements, placing it well within the propulsive abilities of average bicyclists. He talks quite seriously of man-powered flights lasting hours.

Clearly, the branch of aviation dealing with light, slow, low-powered craft — stunted by the advent of motor-powered flight — has sprouted a vigorous new shoot. More research on the peculiar realm of slow flight will certainly be conducted, preparing the way for the first true bird-men.

Says Dr. MacCready, "In just a few years there will be inexpensive machines that fly and soar and glide a lot better than a hawk; that can take off on foot and land on foot safely, and that have auxiliary power — lightweight and well-muffled engines that can get you up from any small field."

Dr. MacCready also believes that the low-speed studies conducted for flight will also influence construction of such energy-conserving devices as fans, pipes, or windmills that move air or other fluids slowly. And man-powered airplane projects in schools could spark interest in engineering, as well as physical fitness.

As a result of his experience with the Kremer competition, Dr. MacCready is advocating the contest as a method to spur innovation: "One does wonder occasionally what would happen if the government decided it wanted to have a man-powered aircraft built. There would be a lot of proposals solicited. Various aerospace firms with a lot of competent people would have to do the major design in the proposal stage, and they'd kind of lock the design in. The winner would probably be the low-bidder, and it would not be a very efficient procedure."

But in a contest the goal is the only thing that matters, and considerable creativity is efficiently brought into play, says Dr. MacCready. "It's somewhat similar to the way a graduate student works on his thesis; after it's finished he'll probably never be as efficient again."

Although Dr. MacCready is a quiet, conservative man, he has clearly been profoundly affected by the achievement he and his ingenious, industrious colleagues have wrought. When asked what good his flight accomplished, he replies: "As with the Apollo mission to the moon, the value is in the event; in raising man's eyes to a broader perspective of his universe, in stimulating new questions, and in the many fallout applications unrelated to the mission. The classic answer to a similar question has been to retort, 'What good is a newborn baby?' " □

## Books and Comment: Adams

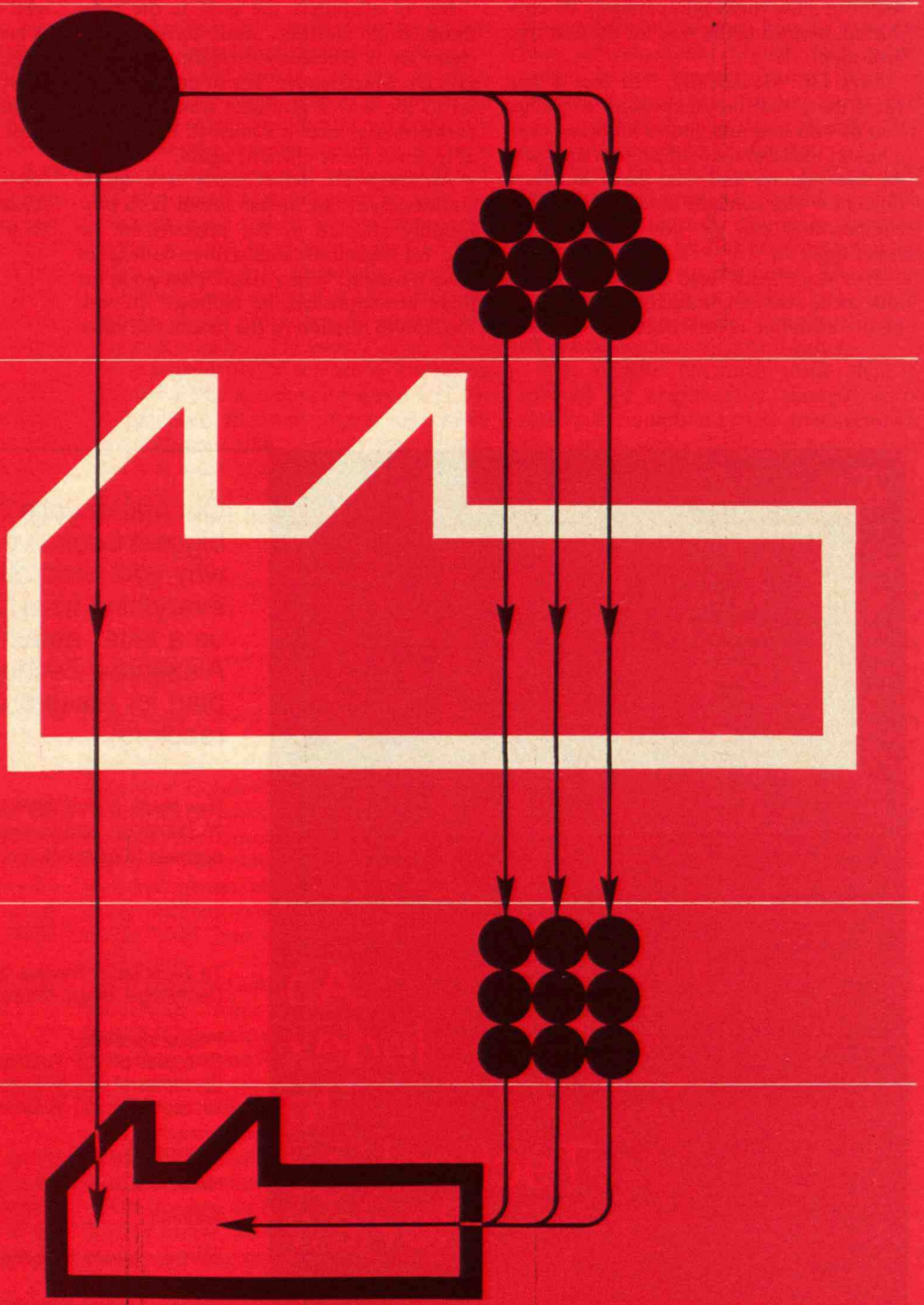
*Continued from p. 13*

something much different. His is a serious book, written in a difficult style. Architecture was, without doubt, a joy to Dr. Burchard and he has united much that goes well together in an instructive synthesis. Whether we look at architecture from the original end of the telescope, as Dr. Burchard has done, or from the derivative end makes little difference — so long as we do look and maybe, once in a while, laugh.

*Nicholas Adams is Associate Professor of History of Architecture at McGill University.* □

# Innovaha!tion

**Steps Leading to the Commercialization of a User-Developed Product**



**1**
New product invented, built and used by innovative user

**2**
New product information diffuses and other users build copies

**3**
First-to-market manufacturer adopts user product design

**4**
And sells as commercial product

**5**
"Me-too" manufacturers enter marketplace

# Users as Innovators

Your customers may already have developed your next new products.

Eric A. von Hippel
Sloan School of Management
M.I.T.

Conventional wisdom holds that customers articulate needs and manufacturers develop products responsive to those needs. But recent research on the histories of many innovative and successful new products has resulted in a different view: in some industries, most commercially successful products are developed by product users, not product manufacturers.

**When the User Becomes the Designer**

As a preview of what is to follow in this article, an example from our research data may be helpful.

The methods used in the mid-1950s by semiconductor manufacturers to bond wires to semiconductor chips were quite unreliable. Three scientists at Bell Telephone Laboratories addressed the problem and developed thermocompression bonding — a greatly improved method which involved heating the semiconductor material and pressing the wire against it. When tests demonstrated the effectiveness of the method, the Bell System developed equipment to implement thermocompression bonding in production — no easy task given the precise control of position, pressure, and temperature required. The method was adopted by Western Electric starting in 1956-57. Other semiconductor manufacturers soon followed, all building the required production equipment in-house.

Two years later, engineers from Kulike and Soffa, a firm specializing in the design and building of production equipment, began working for Western Electric on various production-machine problems. They concluded that machinery implementing several process innovations — including thermocompression bonding — could be sold commercially, so in late 1959 Kulike and Soffa became the first of several firms to manufacture thermocompression bonders for commercial sale. Kulike and Soffa retains a major share of that market today.

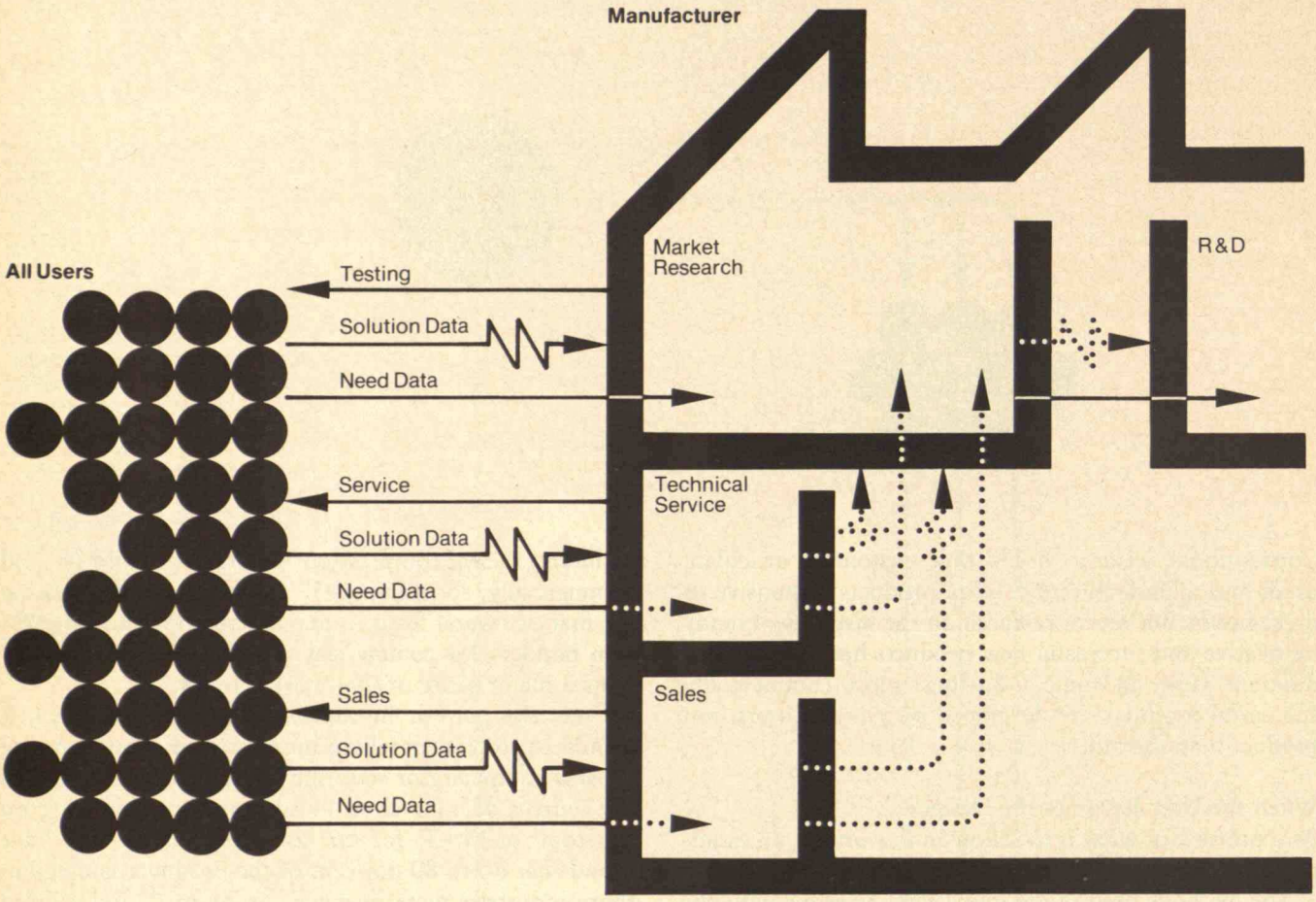
Does the pattern in the example seem familiar? It should be to readers whose business is in manufacturing process equipment or scientific instruments. In studies of the sources of innovation — we have been working on this topic at M.I.T. for the last half-decade — we have found that 60 to 80 per cent of the products sampled in those industries were invented, prototyped, and utilized in the field by innovative users before they were offered commercially by equipment or instrument manufacturing firms.

**Scientific Instruments: Users Make What They Need**

In the case of scientific instruments, we have studied three samples totaling over 100 commercially successful product innovations. The first sample consisted of the first-commercialized versions of four types of scientific instruments: the first gas chromatograph, the first nuclear magnetic resonance spectrometer, the first ultraviolet spectrophotometer (absorption photo-electric type), and the first transmission electron microscope; these are commercially important instruments widely used in the scientific and industrial communities worldwide. Next, we made a survey of expert users and manufacturers to determine a sample of 44 major improvement innovations — judged on the basis of incremental utility offered

(Below) Product manufacturer's conventional interface to product users. Market research, technical service, and sales departments are typically oriented to communications with users on their needs and the manufacturer's responses to those needs. There are multiple barriers, shown by the zig-zagged lines, to flows of information into manufacturers on user-developed products — "solution data," in the author's terminology.

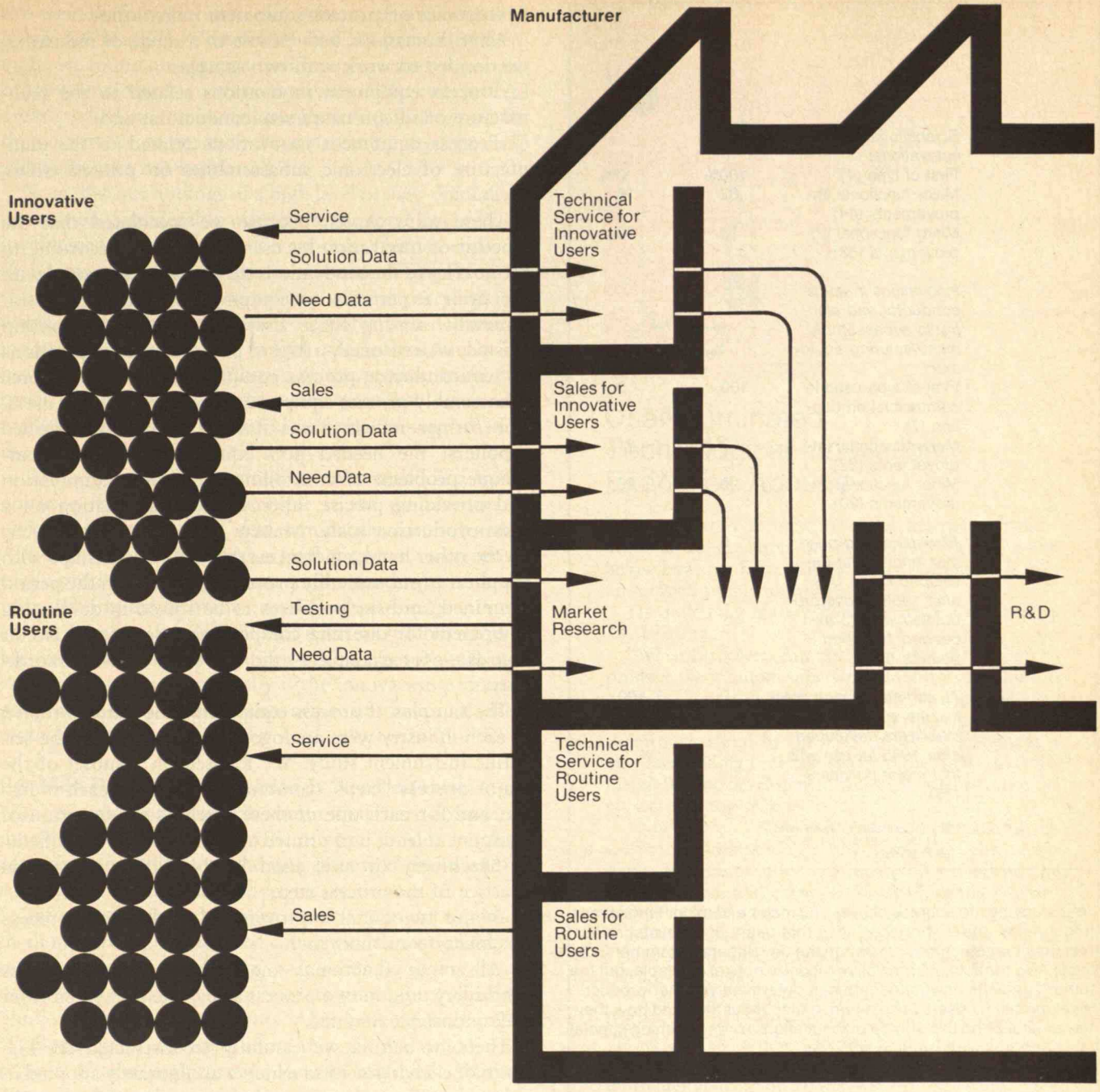
(Right) Proposed manufacturer's interface to innovative users. The reorientation of market research encourages the acquisition by manufacturers of data on user's needs and solutions, and there are special technical service and sales forces to assure that solution as well as need data are embraced and even sought from innovative users.




to the instrument user — to these four basic instruments. And finally, we selected a sample of 63 minor improvement innovations for transmission electron microscopy — the sampling consisting of all commercially successful innovations which offered any incremental functional utility to any subset of users.

The histories of each of these three samples of scientific instrument innovations (identified in the table on page 34 as "basic," "major improvement," and "minor improvement" innovations, respectively) were then carefully acquired. We started by identifying the firm which *first* manufactured the product for commercial sale, thus avoiding instances of "me-too" innovation. We then identified and interviewed personnel of manufacturing companies who were involved in the innovation work, and we also interviewed early users of the device. Related products and publications generated prior to the date of first-to-market commercialization were also collected and studied.

The result of all this work: in 81 per cent of all the innovation cases studied, we found that it was the user who perceived that an advance in instrumentation was required; invented the instrument; built a prototype; improved the prototype's value by applying it; and diffused detailed information on the value of the invention and how the prototype device might be replicated. Only when




all of these steps were completed did the manufacturer of the first commercially available instrument enter the innovation process. Typically, the manufacturer's contribution was to perform product engineering work which, while leaving the basic design and operating principles intact, improved reliability, convenience of operation, etc.; and then to manufacture, market, and sell the improved product.

The frequency with which this user-dominant innovation pattern appeared in our sample of scientific instrument innovations was, as the table on page 34 indicates, strikingly high for basic innovations and for major and minor improvement innovations as well. User-dominant innovation showed no statistically significant relationship to the size — and thus, presumably, to the research and development potential — of the manufacturing company. Furthermore, the pattern of user-dominated innovation appeared to hold for companies which were established manufacturers of a given product line — manufacturers who "ought" to know about improvements needed in their present product line and to be working on them — as well as for manufacturers for whom a given innovation represented their initial entry into a product line.

Our data also showed extensive precommercial diffusion of significant user inventions through "home-built" replications by other users. Indeed, such "home-built"

| | Field of innovations and sample selection criteria* | First device used in the field developed and built: By product user | By product manufacturer |
|---|---|---|---|
| Instrumentation | *Scientific instrument innovations:* | | |
| | First of type (4) | 100% | 0% |
| | Major functional improvements (44) | 82 | 18 |
| | Minor functional improvements (63) | 70 | 30 |
| Process equipment | *Innovations in semiconductor and electronic subassembly manufacturing equipment:* | | |
| | First of type used in commercial production (7) | 100 | 0 |
| | Major functional improvements (22) | 63 | 21 |
| | Minor functional improvements (20) | 20 | 29 |
| Polymers | *All engineering polymer innovations developed in the U.S. after 1955 whose production in 1975 exceeded 10 million pounds* (6) | 0 | 100 |
| Additives | *All commercialized plasticizers and ultraviolet stabilizers developed after 1945 for use with four major polymers* (16) | 0 | 100 |

* Numbers in parentheses indicate the number of cases in each sample

After studying the sources of over 160 major and minor innovations in four fields, the author concludes that users of products, rather than their manufacturers, are often the developers of commercially viable new products. A predictive model is not yet available, but the author suggests how managers can determine whether product development by users is common in their industries and how they may capitalize on this source of innovations by establishing special sales and technical service activities.

replications were made and used to produce publishable results in every case where more than a year elapsed between the initial published description of a significant new instrument innovation by a user and the introduction of the first commercial model by an instrument firm.

### User Innovations in Process Machinery

Having thus discovered a user-dominated innovation pattern in scientific instruments, we next sought to determine whether this was an isolated instance, or whether the pattern held also for other types of innovation in other industries. Because innovation in process equipment is related to such pressing national concerns as the rate of increase of industrial productivity and the international competitiveness of U.S. manufacturers, we decided to focus our next studies on process equipment innovations.

After discussions with people in a range of industries, we decided to work with two samples:

☐ Process equipment innovations related to the manufacture of silicon-based semiconductors; and

☐ Process equipment innovations related to the manufacture of electronic subassemblies on printed circuit cards.

These were chosen because we speculated that the amount of innovation by users might vary according to the novelty of the innovations they needed compared with the prior experience of equipment manufacturers traditionally serving those users. If such a relationship existed, we reasoned, a higher proportion of innovations in semiconductor process equipment than in electronic subassembly process equipment should come from users. The former industry was new; it had no established suppliers; the needed new equipment involved near-unique problems of controlling chemical contamination and providing precise, microscopic manipulation on a mass-production scale. Makers of electronics products, on the other hand, enjoyed established relationships with suppliers of subassembly process equipment in the period examined, and the problems to be solved in developing equipment for inserting components into printed circuit boards — for example — did not seem to us extraordinary.

The samples of process equipment innovations studied in each industry were analogous to those used in the scientific instrument study. We focused on a subset of the major process "steps" commercially used in each industry, and for each one of these (such as the insertion of component leads into printed circuit cards) we identified:

☐ Machinery (if any) used in the initial commercial practice of the process step;

☐ Major functional improvements made in the process machinery over time; and

☐ All minor functional improvements in the process machinery used in two process steps, one step taken from each industry examined.

Then, as before, we carefully reconstructed the histories of each innovation which was ultimately adopted in commercially manufactured process machinery. We searched the appropriate technical literature prior to first commercial innovation seeking references to experimental apparatus functionally similar to the commercialized innovation as well as other relevant work, and we interviewed authors of relevant articles. When we identified user-innovator firms we sought out and interviewed personnel in them; and if we had no information on the presence of user-innovators, we canvassed logical potential user-innovator firms to assure ourselves insofar as we could that such user-innovators indeed did not exist.

We found user-dominated innovation patterns very strongly present in the segments of the process machinery industry we sampled. As the table on this page shows, all of the novel machinery used in the initial commercial practice of a process step and more than 60 per cent of the improvements to that machinery were invented, prototyped, and used in commercial production by innova-

tive users before they were manufactured and marketed by process machinery manufacturing companies. Interestingly, we found no significant difference in the proportion of user-dominated innovation present in the two process areas studied, so our initial speculation as to a reason for the occurrence of product development by users in some industries was not supported.

Note that our findings of a high level of user-dominated innovation considerably understate the total level of user involvement in the innovation process. This is because:

☐ Users can and do sometimes make a considerable contribution to the innovation process without carrying their work far enough to meet our criteria for user-dominated innovation. For example, in four process machinery innovations studied — attributed to the product manufacturer in our results — the users provided machinery manufacturers with the central technical concept used in the innovation; and

☐ Many process innovations are not embodied in innovative hardware. An example is the preparation of dislocation-free crystal for semiconductor substrate. Although "dislocation-free crystal growers" were eventually produced, initial commercial practice was a matter of modifying the technique used to operate conventional crystal growers. It is logical that users would have a very high involvement in innovations of this type, manufacturers having a role occasionally if the innovation promised additional sales of non-innovation hardware of their manufacture.

### But User-Dominated Innovation Is Not Universal

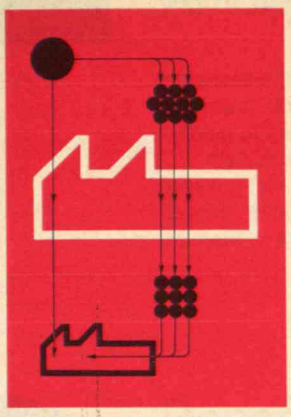
Not-yet-published research shows that user-dominated innovation is also characteristic of some process machine categories in addition to the two discussed above and of some types of medical product innovation.

But user-dominated innovation clearly is *not* common in all industries; in some, the conventional relationship of manufacturer responding to user needs by acting as innovator and product developer is strongly applicable. Studies by two of my students, Alan J. Berger and Julian W. Boyden, for example, show that all innovations in a sample of new engineering polymers and new additives for commodity plastics were developed by manufacturers of these products, not by users *(see the table on page 34)*.

In what industries is the user-dominated pattern common, and in what industries is it rare? A model which would quickly and economically answer this question for particular industries would be useful both to policymakers and to innovators. We are working hard to develop such a model, but it is not ready for presentation yet. Meanwhile . . .

### What To Do Till the Researcher Comes

If you are not involved in the few fields we have examined to date and yet you want to know what innovation pattern prevails in your industry — and you can't wait until we have developed and tested a general model — it is quite possible to "do it yourself." Simply select a sample of innovations of the type in which you are interested and trace back their innovation histories as we have done. If



## User-Dominated Technological Innovation: Examples Abound

When you start to look for them, examples of user-dominated innovation are easy to find. The two noted below have not been independently documented; they are offered simply at face value.

The following is from *Business Week* for February 28, 1977:

"When Lockheed Aircraft Corp. was revving up to produce the titanium superstructure for its revolutionary SR-71 aircraft back in the 1960s, it pioneered a new machining technique to speed the removal of the supertough metal by up to 20 times. The key was a new face-milling tool that shears rather than chips the metal. But the development was kept quiet because the project was top secret.

"Now the tool is being introduced commercially by Cutters Unlimited Co., a tiny Gardena (Calif.) company. Just 15 months old, the company refined the Lockheed tool and expanded its applications to stainless steels and other hard-to-cut alloys."

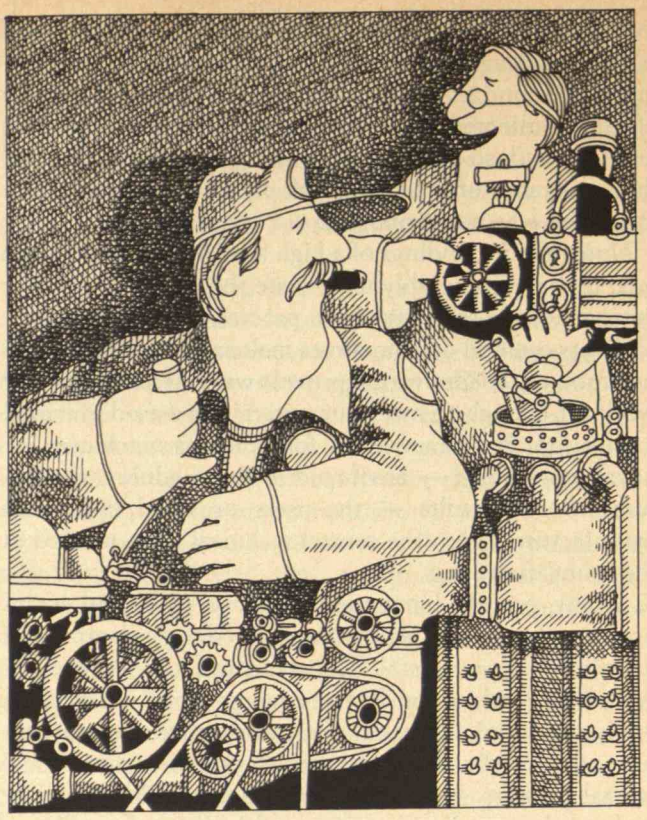
Another example was described by Eastman Kodak Co. in an advertisement published in *Scientific American* for December, 1976:

"*N,N'*-bis[*p*-butosybenzylidene]-α,α'-bi-*p*-toluidine (BBBT) is a mesomorph, more popularly known as a 'liquid crystal,' a new addition to the long list of organic compounds that show interesting kinds of intermolecular association on the way from the solid to the ordinary isotropically liquid state as temperature rises. Beginning on p. 809 of the May, 1976 issue of *Analytical Chemistry*, workers at the National Cancer Institute tell how they prepared BBBT from a simpler Eastman organic chemical and why they have found BBBT better than any previously known substance when used as the stationary phase in gas-liquid chromatography for detecting and distinguishing geometric isomers of polycyclic aromatic hydrocarbons of interest as possible environmental carcinogens.

"On May 14, 1976, we logged in our first inquiry from a scientist who wanted to try BBBT but preferred to buy it instead of spending his time making it. He and all others who need it can now order it from lab suppliers as Eastman Organic Chemical No. 15076."

— *E. A. von H.*

**". . . the conventional interface which product manufacturers present to their customers offers multiple barriers . . ."**



Technical service is interested in maintenance not new products

your findings are as clear as the ones we show in our table, you will have a good feeling for the prevailing pattern after studying only a few cases.

Two points of caution:

☐ When collecting your histories, obtain your information *independently* from users, from manufacturers, and from other innovation participants which your evidence identifies. If you ask *only* users, in effect, "Who invented this wonderful device — you or someone else?" they will quite naturally suggest that they are the true progenitors of everything in sight. If, on the other hand, you ask *only* manufacturer personnel — even yours — they will also claim paternity.

☐ Don't assume you know the innovation pattern which prevails in your industry before you have collected and carefully analyzed the data. Product manufacturers, especially — even in user-dominated industries — "know" they are the real product developers because it is the conventional wisdom; because manufacturer personnel are constantly exposed to their own product development efforts but only occasionally to those of users; and because prototypes developed by users or others are seldom manufactured as received. In other words, casual inspection of an innovation process tends to emphasize the manufacturer's role in it and to mask the value of the contribution brought in from outside the manufacturer's plant.

**The Realm of User-Dominated Management**

The fact that user-dominated innovation characterizes so many new developments need not be a cause for dismay on the part of those concerned about effective and efficient industrial innovation. Accurate understanding of user need is widely regarded as the most important single factor assuring the success of an industrial innovation. Clearly, users who innovate are in an advantageous position to perceive user needs accurately. User-dominated innovation should therefore have unusual potential for success.

But there remains the question of effective strategies for managing user-dominated innovation processes. If your manufacturing firm is in an industry which turns out to be characterized by user-dominated innovation, how should this finding affect your new-product-development effort?

The chart on page 30 indicates the position of the first-to-market firm in a user-dominated innovation process. In the following discussion we focus on the appropriate interface (colored in the figure) of the manufacturer to that process, in contrast to the interface which the manufacturer conventionally has with the user community.

First, consider the conventional interface *(page 32)*. In this interface, no distinction is made between innovative and non-innovative (routine) product users, with the result that personnel from market research, sales, and technical service (the three typical interface units) come

# MIT '78

## Articles:



## Departments



## Financial Operations of the Institute: Past, Present, and Optimistic Future

In sharp contrast with significant deficits during the past three years, the financial operations of the Institute were approximately in balance in 1976-77, Chancellor Paul E. Gray, '54, told the M.I.T. faculty this fall. Barring unexpected developments, he foresees a similar result in the current year; and continued efforts to reduce expenses combined with continuing increases in gifts and grants would make possible modest surpluses in 1978-79 and 1979-80.

His report on Institute finances focused on the outcomes of the last year, projections for the immediate future, and the changing circumstances that influence these outcomes and projections.

**1976-77 Results: an "Insignificant" Shortfall**

"Revenues from all sources, including tuition fees, research cost reimbursement, endowment investment income, restricted gifts for current use, and revenues generated by auxiliary activities were nearly sufficient, when augmented by current unrestricted revenues . . . to cover operating expenses," Dr. Gray explained. The actual shortfall or deficit of $126,000 was less than 0.05 per cent of operating expenses for the year — "insignificant", he believes. (A year ago the operating deficit was $2.6 million and the sum of the deficits in the three years from July, 1973, through June, 1976, was $13.2 million.)

"No portion of the Institute's endowment capital — its funds functioning as endowment — was required in the year to balance the budget. In comparison, in the previous three years the research reserve was drawn down by $3.5 million and funds functioning as endowment were expended to the extent of $4.0 million."

**"We project that the sum of operating revenue from all sources and current unrestricted revenues . . . will be sufficient to just balance operating expenses for the year so that the deficit will again be essentially zero."**

The improvement this year was the result of several favorable factors:

There was a change in the rules by which overhead is calculated on research projects, resulting in "a significant increase in reimbursements for research overhead costs."

Revenues generated by the Industrial Liaison Program exceeded the goals that had been set, as did unrestricted gifts received during the year. (This "strong increase" in gifts — $700,000 above predictions — reflects the success of the M.I.T. Leadership Campaign, now in its third year.) "As a result of the campaign, the total of all gifts, restricted and unrestricted, received during the year increased by 20 per cent," Dr. Gray said.

The operating budgets were underexpended by $200,000 more than expected. Operating expenses of the Institute totaled $276.9 million — an increase of only 2.8 per cent over last year.

## Outlook for the Current Year: Precarious Balance

Total expenditures of $309 million are projected as the operating budget for the current year, an increase of about 10 per cent over last year. A forecast 13-per-cent increase in the direct expenditures for research on the campus and at Lincoln Laboratory is reflected in that total.

"We project that the sum of operating revenues from all sources and current unrestricted revenues . . . (including gifts and bequests, patent revenues, and use of facilities allowances) will be sufficient to just balance operating expenses for the year so that the deficit will again be essentially zero," Dr. Gray said.

But he added that "this is an unsatisfactory and precarious balance."

"It is unsatisfactory because it requires the use of essentially all current unrestricted funds for current operations. . . . We feel that a more responsible and reasonable balance between current and future needs requires setting aside each year some portion of current unrestricted receipts for capital purposes, such as additions to endowment capital or investment in plant.

"The balance is precarious because there is no margin which can be used to absorb unforeseen perturbations in revenues or expenses. . . . In particular, our projections for the next year leave no margin to accommodate actions of the federal government — actions which are increasingly hard to predict or anticipate."

## Considerations for the Future: Recurring Needs

Projections of Institute finances extend three years into the future: " . . . Under an appropriate set of stringent but not unreasonable conditions, each of the three years beyond the current one could close without deficits and with an excess of current unrestricted funds of $200,000 to $400,000 in each year. The projected cumulative excess is $900,000.

"The principal assumptions on which these projections are based are the following:

"1. Inflation in the economy will remain in the range of 5 to 7 per cent per year, and costs incurred by the Institute, including the costs of materials, services, and personnel, will increase, on the average, at similar rates.

"2. The tuition fee will increase by 6 to 7 per cent per year.

"3. The population of regular students will remain at the present levels.

"4. Revenues from the Industrial Liaison Program will be maintained at present levels, and current unrestricted gifts will continue to increase at rates characteristic of the past two years.

"5. Distributed investment income will grow at the rate of 3 to 4 per cent per year.

"6. Expenditures will be reduced, before salary and wage changes, by $350,000 (net of indirect cost recovery reductions) in 1978-79 and by $250,000 (net) in each of the following two years.

### How Social Security, Retirement Changes Jeopardize M.I.T.'s Balanced Budget

If M.I.T.'s projected 1977-78 balance of operating revenues and expenses is "precarious" — and therefore "unsatisfactory," as Paul E. Gray, '54, Chancellor, told the faculty last fall (*see right*), that is at least partly because there is "no margin to accommodate actions of the federal government . . . which are increasingly hard to predict or anticipate."

Dr. Gray then went on to speak of two current issues which would have "major consequences for the Institute and for other universities," he said.

Several forms of change in Social Security financing being considered in Congress could add $1 million to M.I.T.'s annual payroll. Two-thirds of this might be reimbursed by research sponsors, but $350,000 (the portion allocated to the Institute's educational programs) would be added "directly to the Institute's 'bottom line' as an additional need for current unrestricted funds or an increase in the operating deficit.

"The proponents of this legislation have argued that the effects on business and industry will be small, that part of the impact will be recovered by reduced corporate income taxes and that the rest can be passed along to the customers," the Chancellor explained. But "I doubt that students or parents, at M.I.T. or elsewhere, will be sanguine about the prospect of absorbing, through additional tuition increases, these new costs."

Eliminating mandatory retirement would also have the net effect of increasing payroll costs. This is because "retirement of high-salaried personnel will be delayed, as will their replacement by much younger people who at first command lower salaries. The net effect will be "to reduce the Institute's opportunity to employ young persons, particularly in the ranks of the faculty . . . We will be hard put to avoid declines in both the rate at which new assistant professors are hired and the rate at which tenure is awarded."

Dr. Gray pointed out that private retirement plans such as those of M.I.T. are "developed and funded with 40-year horizons," as are arrangements for tenure, and he finds "precious little evidence of Congressional consideration of the full consequences of its precipitant action."

Indeed, he told the faculty, "we seem to be moving into an era of the 'quick fix,' of inadequately considered actions which have enormous social consequences, but which are undertaken on the basis of relatively casual deliberations about their implications and full impact. These patterns do not bode well for the future of the nation, let alone the universities."

**"All of us who are involved with Institute operations are gratified by the attainment, a year earlier than we dared hope, of a balanced budget. The well-worn phrase 'cautious optimism' fits well in this case."**

"While the reduction for next year was contemplated a year ago when we made budget commitments for two years, and thus should be relatively easy to achieve, the reductions for the next two years will come after a full decade of cost control efforts and will represent a more difficult and painful challenge."

There are two cautions concerning these projections: first, they contain insufficient allowance for new financial resources required by the School of Engineering to cope with continuing increases in undergraduate majors (65 per cent of sophomores were registered in the School of Engineering this fall, compared with 45 per cent in the 1972-73 year). Resources to accommodate this increased enrollment could add as much as $0.5 million to annual operating expenses.

Second, the projections "do not reflect the consequences of unforeseen and unpredictable government actions and legislation."

Dr. Gray concluded: "All of us who are involved with Institute operations are gratified by the attainment, a year earlier than we dared hope, of a balanced budget. The well-worn phrase 'cautious optimism' fits well in this case.

"This outcome, however, does not mean that we can relax our broadly-based efforts to control costs and generate new recurring revenues. Even without the threats from Washington, the Institute will at best remain poised over the next three years on the narrow edge of balance. We must, in the long run, do better than that." — *M.L.*

*Beth Marcus, '79, is Vice President of her class, the sports editor of* Technique, *the social chairman of Burton House and a member of the swim team and women's crew. From New York City, she is studying mechanical engineering with a special interest in bio medical engineering.*

## "Thing of the Mountain" Contest: "It Works! . . . Well, Sort of . . ."

*by Beth Marcus, '79*

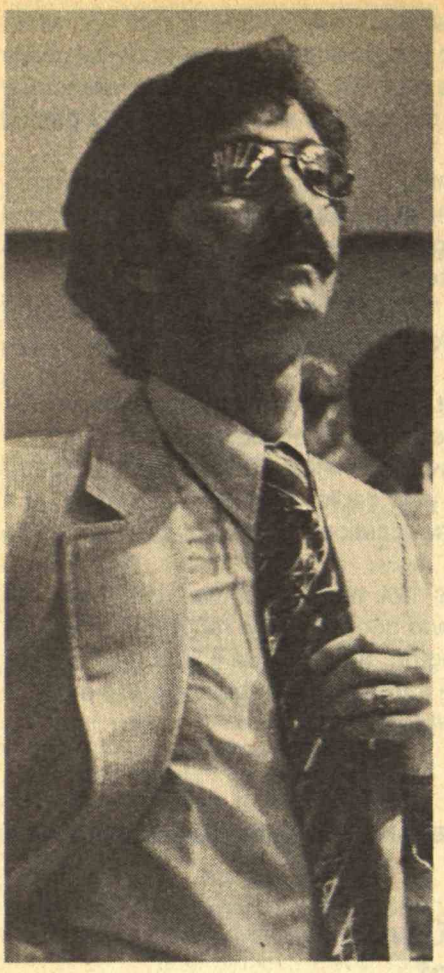
Last fall, 150 students filed into room 3-270 as usual and took their seats. They were told that the movie they were about to see could give them many insights into the project on which they were about to embark. The course was 2.70 Introduction to Design; the project was the annual design contest which had been part of the course since the fall of 1971. "The Tugger War," was a movie about the previous year's contest. Things like: "I wish I had another day," "The first one never works," "Now what do I do?," "It works. . . . well sort of," were said the day before the contest.

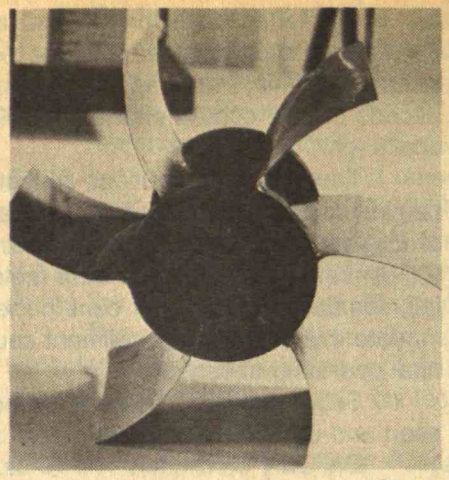
I looked around the room at the spellbound faces. Who will win this year? Will I? If not, why not? Some of the students in the movie were frustrated, some were elated. Where will I be the day before the contest?

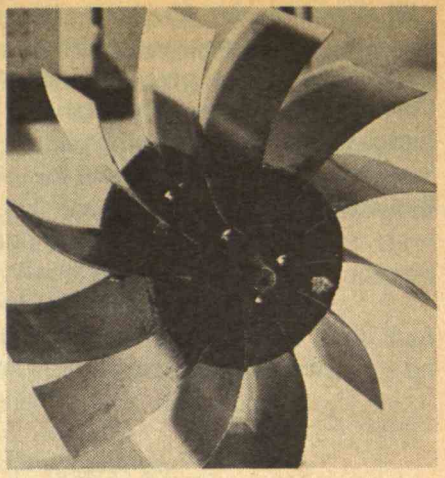
The lights went on and I felt relieved as the tension left the air. Well, I have plenty of time to worry about that, I thought. But the tension returned as Professor Flowers passed out the handout titled "Thing of the Mountain." There was silence again.

"2.70 Project #1, Fall 1977, Thing of the Mountain," I read. "Object: To design and build a device which wins a series of contests, in each of which it must 'outclimb' an opponent's device on a specified sand mountain."

Except glues, adhesives (to be used only for bonding), and nonfunctional decorations, the "Things" are to be constructed solely from the materials supplied in the kit (which was handed out about a week later). The energy, to be delivered via the power leads (for ten seconds), must be transformed into mechanical energy solely by the Polaroid camera motor provided in each kit. No other form of energy can be used by the "Things" to accomplish their objective. The deadline was 5½ weeks away. "An overall 'winner' will be chosen in a single-elimination tournament. The winner of each climb-







*Professor Woody Flowers, Ph.D. '75, (above) watches the results of his class problem. Trial and error prompt an evolution of parts for Ms. Marcus' "Thing" (top middle, top right).*

off will be the device having its lowest visible point higher on the mountain than the lowest visible point of its opponent. A device still moving 30 seconds after the 'start' time will be disqualified."

I looked up. Images of "Things" climbing sand mountains flashed through my head; tractors, tanks, dune buggies, hover crafts, catapults, and many other devices (most of which could never work). I wonder what's in the kit, I thought, as I read the problem for a second time.

That Monday I went to my lab section and was told that by the following meeting I should draw up five of my ideas on the project. That week we also got the kit. As advised by some of my friends who had previously taken the course, I began to experiment with the materials. When I was satisfied that I had the answer, I drew up the plans for *Scorpion #3* (One and Two being experimental models which were run on the carpet of my room). By this time Eric, one of the other students, had his vehicle built and running, and it got to the top of the hill in less than two seconds. The thought of that worried us all.

I finished building *Scorpion #3* about a week and a half before the contest. I brought it to the mountain, whereupon it began to dig itself into a hole at the bottom of the hill. Then it stalled. I worked on the drive system until the vehicle ran well on my carpet. Then I returned to the hill.

This time it didn't stall, but it made quite a mess throwing sand everywhere for ten seconds. By that time I noticed that no one else was using skids, and the people who were succeeding in getting their devices to the top of the hill were those with light vehicles. So I replaced the skids with a roller and drilled holes in every solid part of the vehicle.

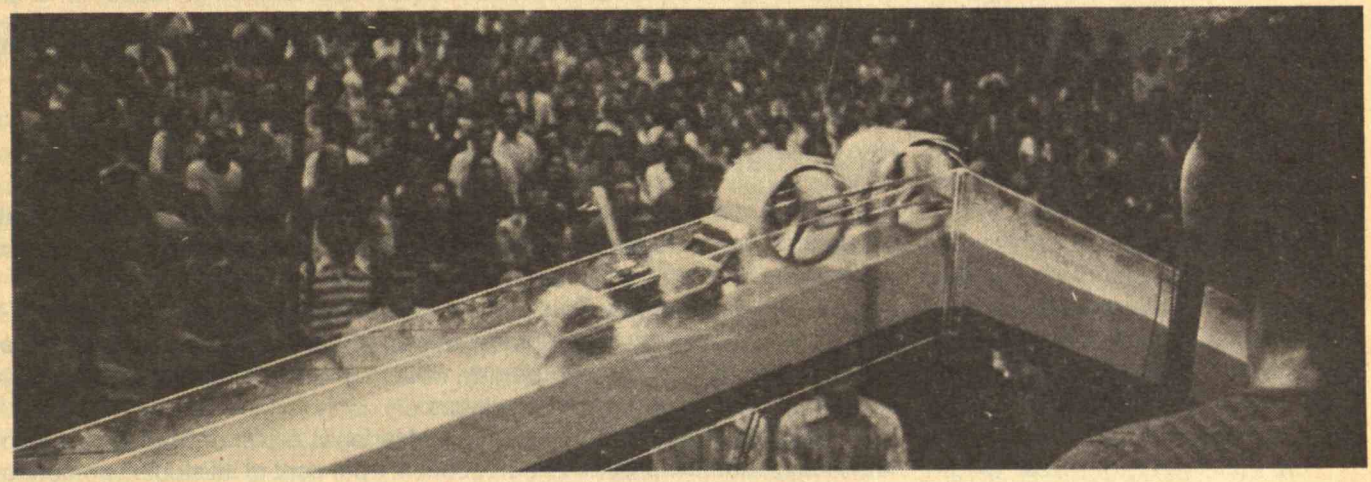
I had noticed also that many people were changing to string drives, for two reasons. One was that it gave them a very simple method of stopping when they got to the top. The other was that many people had discovered that front-wheel drives (at least in the form that they were being used) had a tendency to dig into the sand, while string drives gave the flexibility of changing the direction in which the vehicle moves. So I changed to a direct drive to make my vehicle more compact, and to a string drive for flexibility.

**"Images of 'Things' climbing sand mountains flashed through my head; tractors, tanks, dune buggies, hover crafts, catapults, and many other devices (most of which could never work.)"**

It was the Monday evening before the contest, and I decided that if it didn't work this time, I would make it look good and go to sleep (since I had been awake for quite a while). I met several people on the way to the hill whose vehicles looked great; upon further investigation they said that they had given up on making it work and had decided to try to make it into a spectacular flop, as suggested by the professor at our last class meeting.

This time when I got to the hill it *moved*! But only a few inches. At the suggestion of one of the other students present, I turned it around, and it went about two-thirds of the way up the hill in ten seconds.

I took it home with mixed feelings. I was happy that it had worked, but sad because I would lose another night's sleep. I found myself wishing that I had more time.



*The winner of the contest, John E. York, '80, (top left) adjusts his project on the "mountain" before the final run when an enthusiastic audience cheered on the winner. (Photos: Beth Marcus, '79, Gordon Haff, '79)*

**"The great thing was how everyone helped each other. If someone lost a part or broke one, several people would offer their assistance."**

This time I made the frame as light as I could get it and made the roller into two wheels which were lighter. It was now 6:00 a.m. on Tuesday, and once more I was at the hill. It went to the top in about three seconds. Needless to say I was *very* happy. At this point I had little faith in *Scorpion #7*'s winning capabilities, but I knew that it would put on a good show. This feeling was mainly due to the fact that several people had gotten to the top in less than two seconds. I went home and painted it and relaxed. At 11:30 I trudged off to 26-100 carrying my "Thing" and all my camera equipment.

After I saw and photographed several competitions, I began to get nervous. There were many vehicles which either didn't move at all or didn't get all the way to the top. Maybe I will do better than I expected, I thought.

In the first round I was lucky. The glue that held my axle together broke after it moved slightly, but my opponent's didn't move at all, so I won anyway. (The glue was Eastman 910 which only bonds wood to metal sometimes, although when I got it into a cut it did a good job of bonding my skin together.)

*Then I slept for 22 hours.*

**"Some vehicles threw sand, some flew to the top of the hill and stopped, a few just kept on going over their opponent and off the hill completely."**

Before the contest on Thursday I nervously sat and watched five-minute epoxy take over half an hour to harden on my axle, and hoped that it would hold. Those of us who hadn't lost, sat in the room together, furiously working on our vehicles and marvelling at everyone else's "Things." But the great thing was how everyone helped each other. If someone lost a part or broke one, several people would offer their assistance.

I watched the competition, first on the right hill, then on the left. The red light flashed, signaling which hill was next, then the green, and in a few seconds it was over. Some vehicles threw sand, some flew to the top of the hill and stopped, a few just kept on going over their opponent and off the hill completely. Now it was my turn. My vehicle did just as planned and won. But in a close race I lost the next round. It was over for me, I was relieved. I sat back and enjoyed the rest of the competition.

## Helping Minorities Stay in Engineering: Toward "a Society in Which Race No Longer Matters"

"Movement toward a more equitable and humane social order, in which racial differences are increasingly irrelevant, depends upon greater access to the professions, including engineering, by minorities."

That statement by Paul E. Gray, '54, Chancellor, was really the keynote — why more than 150 representatives of some 90 organizations came to M.I.T. late last fall for a three-day workshop on the retention of minority undergraduates in engineering colleges.

Statistics cited at the workshop by Marion L. Oliver of Carnegie-Mellon University made the problem clear: about 4.1 per cent of all students entering U.S. engineering schools in 1973 were black; by 1975, when the same class had become juniors, the percentage of blacks in it had fallen to 2.8; and by graduation the number of blacks had slipped to 2 per cent.

Lots of people have tried lots of experiments to try to change that gloomy picture, says Professor Wesley L. Harris, Director of M.I.T.'s Office of Minority Education. The point of the workshop, co-sponsored by M.I.T. and the Committee on Minorities in Engineering of the National Research Council, was to see what works and what doesn't.

### Six Responses to Improve Engineering for All

Six points with which most workshop participants agreed were outlined by Dr. Gray, in a major address:

☐ *Financial aid.* On average, minority students are likely to come from families whose resources are below national norms. "Those minority students

cannot perform up to their abilities, let alone up to our expectations for them, if they are constantly worried either about how to eat next week and how to buy next term's textbooks or about the impact of their education on the welfare of their families," said Dr. Gray.

☐ *Effective advising.* Engineering programs tend to be sequential, one course building upon fundamentals taught in the preceding course; so the tolerance for error in planning programs and completing requirements is smaller than in fields such as the liberal arts. But Dr. Gray believes that "many — but by no means all — minority students who enroll in engineering operate in a mode in which the margins for error, for false starts, for wrong choices, or for other academic misadventures are smaller . . ." Dr. Oliver agreed, noting his belief that many minority students fail "because they don't have a sense that there is somebody there that cares about them."

☐ *Flexibility in progress.* Just because 80 per cent of the undergraduates do so is no reason to believe that everyone should finish an undergraduate engineering education in four years. Dr. Gray says variability is "entirely normal," and minority students should be encouraged to think that way.

☐ *Transition to college.* A social environment offering more freedom sometimes conflicts with the intensity of purpose required for success in college — especially in engineering. This makes the adjustment from high school to professional school "a wrenching one," said Dr. Gray, and he thinks special programs such as M.I.T.'s "Project Interphase" — a seven-week, pre-freshman-year summer study in calculus, physics, chemistry, and humanities — are urgently needed.

☐ *Academic support.* Many minority students turn out to need special help with fast-paced engineering studies, said Dr. Gray — not because of the students' ability or potential but because of their prior educational experience. M.I.T.'s program of special video instruction has been a successful response, Dr. Gray thinks: lectures in large core subjects are videotaped and then played back to small groups of students with a tutor. (Edward R. Kane, President of E. I. du Pont de Nemours and Co. who is Chairman of the National Advisory Council on Minorities in Engineering, thinks the problem should also be tackled at the high school level. "To take the big step forward that the retention problem needs, we have to take a big step back — back into junior high school or earlier," he told the conference.)

☐ *Flexibility in recognizing and correcting errors.* Despite our best efforts to help them, some students in engineering schools will simply turn out to be in the wrong place, unable to succeed. No stigma need be attached to this, Dr. Gray said; instead, our goal should be to encourage and help these young people find other outlets for their skills, being at the same time "grateful for the variability of human nature and the plasticity of intelligence and capacity" which these experiences suggest.

There is nothing unique about minority students' problems, said Dr. Gray, and our experience with them should "help us serve better the needs of all our students." — *J.M.*

**Paul E. Gray, '54, Chancellor, speaking to the Workshop on the Retention of Minority Undergraduate Students in Engineering: "I am hopeful that the decision of the Supreme Court (in the case of The Regents of the University of California vs. Allan Bakke) will embrace what can be seen as the paradox of our time. While moving toward a society in which race no longer matters, we must, for the present, take account of race in access to higher learning. There is, I am convinced, no other way."**

*G. M. Whitesides*

**Whitesides is Cope Professor**

The Arthur C. Cope Professorship in Chemistry is now occupied by George M. Whitesides, an organic chemist whose research has ranged from organometallic chemistry to magnetic resonance spectroscopy and enzyme technology.

The professorship honors the late Arthur C. Cope, himself a distinguished organic chemist, who was Head of the Department from 1945 to 1965 and who brought Professor Whitesides to the Institute in 1963. Since then, Professor Whitesides has earned a reputation as an effective teacher and as a leader in curriculum development as well as an important research scientist. He held an Alfred P. Sloan Fellowship in 1968 and won the prestigious Award in Pure Chemistry of the American Chemical Society in 1975.

## I

### Civil Engineering

**Clair N. Sawyer** has been named the recipient of the Gordon Maskew Fair Medal by the Water Pollution Control Federation for "proficient accomplishment in the training and development of engineers." He was a member of the M.I.T. faculty from 1945 until 1958.

The American Society of Civil Engineers has elected as a Vice President **Cranston R. Rogers,** S.M. '51, Vice President and Manager of C. E. Maguire, Waltham, Mass.

*C. N. Sawyer*

## III

### Materials Science

**Jon C. Goldman,** Ph.D. '71, has recently joined Advanced Semiconductor Materials/America as its Director of Process Development . . . **Raymond R. Fessler,** Sc.D. '65, has been named Manager of Physical and Applied Metallurgy Research at Batelle's Columbus, Ohio, laboratories . . . **Michael K. Korenko,** Sc.D. '73, is currently a Lecturer in Materials Science at the Joint Center for Graduate Study, Tri Cities, Wash. . . . **Albert Paladino, Jr.,** Sc.D. '62, has received a two-year appointment in the Office of Technology Assessment as Program Manager for Materials and Resources.

## V

### Chemistry

**Carol Kandall,** Ph.D. '65, is currently in residence in obstetrics and gynecology at Yale-New Haven Hospital after having completed medical school at Yale . . . **Donald W. Shive,** Ph.D. '69, has been named recipient of the 1977 Lindback Award for "distinguished teaching" at Muhlenberg College, Allentown, Penn. He joined the chemistry faculty there in 1969 . . . **Tung-Po Lin,** Ph.D. '58, has been appointed to the Chair of the Department of Mathematics at California State University in Northridge, Calif.

## VI

### Electrical Engineering

After seven years on the staff of the Artificial Intelligence Laboratory, **Harold Abelson,** Ph.D. '73, has joined the faculty as Assistant Professor in the Department of Electrical Engineering and Computer Science; he continues his affiliation with A.I. and is also Assistant Professor in the Division for Study and Research in Education. Dr. Abelson's research is in theoretical computer science, computational complexity, and algebraic topology; he's a member of the Logo Project, a group investigating how computer technology may enhance education.

**John Kreifeldt,** E.E. '63, has received a $100,000 grant from the National Aeronautics and Space Administration to research and develop a system which would allow airplane pilots to "see" other planes in their vicinity on a radar screen in the cockpit . . . A delegation of ten members of the Institute of Electrical and Electronics Engineers, including **Paul E. Green, Jr.,** Sc.D. '53, and **Robert M. Lerner,** Sc.D. '59, visited the People's Republic of China as guests of the Chinese Electronics Society, in order to discuss and work toward future international technical exchanges.

In order to help focus attention on the often misunderstood and underappreciated role of technology in modern society, the recent National Symposium on Technology and Society resulted in the creation of a national task force, chaired by **Edward E. David, Jr.,** Sc.D. '47, President of Exxon Research and Engineering Company . . . **W. David Gregg,** S.M. '62, has just written *Analog and Digital Communication: Concepts, Systems, Applications, and Services in Electrical Dissemination of Aural, Visual, and Data Information,* published by John Wiley & Sons, New York, N.Y. . . . **Elliot N. Pinson,** S.M. '57, has been named Director of the new Business Communications Systems Laboratory, Bell Laboratories, Denver, Colo. . . . **Richard Swerdlow,** S.M. '62, spent the end of last year on a scientific expedition to the Grenadines where he studied corals through Earthwatch and assisted in data analysis and data gathering . . . **D. G. O'Brien,** S.M. '51, addressed seniors at the Framingham State College annual Investiture Assembly. He told them that good tools, materials, determination, and an idea are what it takes to be a success in life.

## VI-A

### Cooperative Program in Electrical Engineering and Computer Science

Two VI-A alumni who are currently serving on the Visiting Committee of the Electrical Engineering and Computer Science Department were at the Institute for the annual meeting on October 27-28: **Joseph F. Keithley,** '37, Chairman of Keithley Instruments, Inc., and **Howard L. Richardson,** '31, a Corporate Director and Consultant. Mr. Keithley did his VI-A work with the Bell System and Mr. Richardson did his with the General Electric Co., Pittsfield, Mass.

On a flight to Washington, D.C., on November 3, to visit current VI-A students working at N.S.W.C. (formerly N.O.L.), Mr. Tucker met **Vernon E. Altman,** '71. Vernon is affiliated with Bain & Co. of Boston. He and his wife and child have

recently moved to Munich, West Germany, where he'll be consulting for several years with a client of Bain's. On this same flight Mr. Tucker sat with **Ronald J. Massa,** '56. Ron is President of Dynatrend, Inc., with its main office in Burlington, Mass.

Hughes Aircraft Co. officials gave a placement seminar on campus in October. Among their representatives was **David E. Gillis,** '57. Dave is an Assistant Manager in the Laser and Electro-Optical Systems Laboratory, Culver City, Calif.

Also on campus for placement business were **S. Dana Seccombe,** '70, representing the Hewlett-Packard Co.'s Loveland Co. Division; and **David M. Bernstein,** '74, representing TRW, Inc. Dave is with TRW's Defense and Space Systems Group in Redondo Beach, Calif. Other VI-A's we know of working for H-P/Loveland are **Jerry D. Metz,** '76, **James M. Mikkelson,** '70, and **Steven E. Richardson,** '73.

**Herbert H. Woodson,** '51, stopped by one afternoon to talk with Mr. Tucker. Herb is Professor and Head of the Electrical Engineering Department at the University of Texas at Austin as well as being Director of the University's Center for Energy Studies.

Professor Emeritus **Karl L. Wildes,** who was associated with the VI-A Program when it was under Professor Timbie's direction, has an office within the suite of VI-A offices. A recent visitor of Karl's was Mr. **Takashi Mitsutomi,** '52, who is now President of HYCOM in Irvine, Calif. Mr. Mitsutomi was formerly with Rockwell International.

VI-A had the distinction of having one its present students receive the I.E.E.E.'s Charles LeGeyt Fortescue Fellowship for graduate study this year. **Michael R. Lowry,** '77, is the recipient and he's affiliated with the Lincoln Laboratory pursuing his VI-A graduate work assignments.

This is the second "VI-A Newsletter" to be included as a part of *Technology Review.* This idea has brought a lot of favorable response so we hope to continue it on a more or less regular basis with future issues. VI-A alumni/nae are urged to send notes of interest to the VI-A Office, M.I.T., Rm. 38-473, Cambridge, Mass. 02139.

# VIII
## Physics

Associate Professor **Ulrich J. Becker,** who was associated with Professor Samuel C. C. Ting in the discovery of the "J" particle, has been promoted to full Professor. He's continuing work in high-energy physics, searching for new members of the "J"-particle family. A native of Germany, he came to M.I.T. after receiving his doctorate at the University of Hamburg in 1968.

**Miklos Porkolab** studied physics at Stanford (Ph.D. 1967) and then for a decade was associated with the Plasma Physics Laboratory at Princeton. Last year he came to M.I.T. as Visiting Professor and this fall he has been named full Professor. His research is in the M.I.T. Plasma Fusion Center on the VERSATOR and ALCATOR experiments.

**Margaret Weiler,** Ph.D. '77, has joined the faculty as Assistant Professor; since 1965 she has been a staff member and Research Assistant at the Francis Bitter National Magnet Laboratory, working in semiconductor magneto-optics and nonlinear optics.

# X
## Chemical Engineering

**A. F. Stancell,** Sc.D. '62, was recently promoted to Vice President and General Manager in Mobil's Plastics Division . . . **David S. Hacker,** S.M. '50, is in the Department of Energy Engineering at the University of Illinois, Chicago, studying the problems of small power cycles with a primary interest in the use of reacting mixtures as potential working fluids . . . **Elizabeth Bagnall,** S.M. '75, has joined the Research and Development Center, F.M.C. Corporation, Princeton, N.J., as a research engineer . . . **Robert Tesoro,** S.M. '48,

### Fred Terman: Architect of The West's Route 128

They call him "The Wizard of 'Silicon Gulch' " — "more than any other single individual" responsible for the glittering stretch of the peninsula south of San Francisco where high-technology companies making semiconductors have assembled what "may well be the most intense concentration of electrical engineering talent in the world."

They're talking about Frederick E. Terman, '24; and the quotations express one reason for two honors which came to Dr. Terman late last year:

☐ Stanford University, where he's been teaching since the 1920s, dedicated a new $9.2 million engineering building in Dr. Terman's honor on October 6. The funds for the Frederick E. Terman Engineering Building came from David Packard and William R. Hewlett, S.M. '36, whose names are together on the letterhead of one of "Silicon Gulch's" most successful pioneers.

☐ The Exploratorium, San Francisco's innovative science museum, honored Dr. Terman at a testimonial dinner on October 11. After Nobel laureates and other members of the Bay Area scientific community played, pushed, and tinkered with Exploratorium exhibits, Mr. Hewlett, who was Honorary Chairman of the event, paid a special tribute to Dr. Terman for his 50 years of leadership in bringing science and technology to Northern California. Paul M. Cook, '47, President of Raychem Corp., was Chairman, and among distinguished guests were Robert N. Noyce, Ph.D. '53, Chairman of Intel Corp., and Albert H. Bowker, '41, Chancellor of the University of California at Berkeley. The M.I.T. Club of San Francisco was represented by H. Debose Montgomery, Jr., '71, Philip L. Molten, '55, and William P. Parker, '74, artist-in-residence at the Exploratorium.

Dr. Terman came to M.I.T. to study with Vannevar Bush, '16, in 1922 after earning his undergraduate degree at Harvard; two years later he won the eighth Ph.D. degree given by M.I.T. in electrical engineering, and he was on his way back home to California to be an assistant professor at Stanford. By 1937 he was Chairman of the Department; he returned from World War II service to become Dean of Engineering, and he retired in 1965 after several years' service as Stanford's Provost.

*". . . honored for his distinguished career as a scientist and educator and for his remarkable contribution to the academic and business community. Dr. Terman's influence on the electronics industry and science-based companies is legendary." William R. Hewlett, S.M. '36, is reading the tribute to Frederick E. Terman, '24 (left), at a dinner in Dr. Terman's honor at the Exploratorium in San Francisco on October 11. Mr. Hewlett was Honorary Chairman of the event, and Paul M. Cook, '47, was Chairman. (Photo: Susan Schwartzenberg from the Exploratorium)*

*R. Tesoro*

has been appointed Manager, Operations Division of the Petrochemical Department of Texaco, Inc., Bellaire, Tex.

## XI
### Urban Studies and Planning

**Lawrence S. Bacow,** '72, who is completing his doctorate in the Kennedy School of Government at Harvard, is Assistant Professor and postdoctoral fellow in the Department. He attended Harvard Law School after leaving M.I.T., and he has worked on the design and implementation of regulatory policy for the Department of Labor, Environmental Protection Agency, Council of Economic Advisers, and Rand Corp.

**Joseph E. O'Brien,** S.M. '58, has received the Meritorious Service Award of the Massachusetts Waste Water Treatment Plant Operators Association . . . **Donna Berman,** M.C.P. '72, is chief of the Massachusetts Port Authority's Office of Noise Abatement at Logan Airport. Her agency acts as a forum for cooperative efforts among airlines, pilots, government agencies, and the community, in handling airport noise problems . . . **Perry L. McCarty,** Sc.D. '57, has received the Harrison Prescott Eddy Medal, given by the Water Pollution Control Federation for "outstanding research, contributing in an important degree to the existing knowledge of the fundamental principles or processes of wastewater treatment."

## XII
### Earth and Planetary Sciences

**Edward A. Boyle,** Ph.D. '76, has completed a postdoctoral fellowship at the University of Edinburgh and is now Assistant Professor in the Department of Earth and Planetary Sciences, working in the chemical composition of seawater, rivers, and estuaries. Professor Boyle first came to M.I.T. from the University of California at San Diego (B.A. 1971), and his doctorate was earned in the joint M.I.T.-Woods Hole program.

**Charles C. Eriksen,** Ph.D. '77, another M.I.T.-Woods Hole graduate, has also joined the Department as Assistant Professor. His research is on waves and currents in the deep ocean, the subject on which he worked at Woods Hole Oceanographic Institution during a postdoctoral year in 1976-77.

## XV
### Management

**Gabriel R. Bitran,** Ph.D. '75, whose doctorate was in the field of operations research, is now Assistant Professor. A native of Brazil, he studied industrial engineering at the University São Paulo before coming to the U.S. in 1972.

**Stephen C. Graves,** who was appointed Assistant Professor last fall, has degrees in mathematics and economics from Dartmouth (A.B. 1973), business administration from the Tuck School (M.B.A. 1974, and operations research from the University of Rochester (Ph.D. 1977).

**Gilbert W. Low,** Ph.D. '77, who became Research Associate with the System Dynamics Group early last year, has now become Assistant Professor. Before returning to M.I.T. for his doctorate, Professor Low was with the Morgan Guarantee Trust Co. of New York for nine years, rising to the level of Vice President, and at the same time worked part time with the International Bank for Reconstruction and Development. Following undergraduate work in political science at Dartmouth (A.B., 1961), Dr. Low studied politics and economics at Magdalen College, Oxford, as a Rhodes Scholar (B.A. 1963).

*R. B. Peterson*

*E. Endresen, Jr.*

**Ronald B. Peterson,** S.M. '73, has been elected President of Grumman Energy Systems, Inc., which produces solar collectors and wind turbines . . . **Endre Endresen, Jr.,** S.M. '62, has been appointed to the position of Senior Vice President, Manufacturing, for Ocean Spray Cranberries, Inc., Plymouth, Mass. . . . **Ed Dodson,** S.M. '61, is the Director of the Metropolitan Transit District, Santa Barbara, Calif. . . . **Lyle W. Talbott,** S.M. '77, has been promoted to Manager, Evaluation and Planning, at the Mining Group of Earth Resources Company, Golden, Colo. . . . **Philip J. Pyburn,** S.M. '73, has been appointed to the faculty of the

Computer Systems Department at Bentley College in Waltham, Mass.

# XVII
## Political Science

**Deborah A. Stone,** Ph.D. '76, has returned to M.I.T. to join the faculty after a year of teaching at Duke University, where she was Lecturer in 1974 to 1976 and Assistant Professor of Policy Science and Political Science in 1976-77. As Assistant Professor of Political Science at M.I.T., she's teaching courses in American politics and public policy.

# XVIII
## Mathematics

**Danielle Goldman-Hilhorst,** S.M. '75, obtained a "doctorat de troisième cycle" at the University of Orsay, France, and is presently doing research in numerical analysis at the "Mathematisch Centrum," Amsterdam, Holland.

# XX
## Nutrition and Food Science

**Robert S. Langer, Jr.,** Sc.D. '74, has been a research associate at Children's Hospital Medical Center of Harvard Medical School working on cancer chemotherapy since completing his M.I.T. degree. Now he's back at M.I.T. for two years as Visiting Assistant Professor, studying and teaching applications of chemical engineering (the field in which he received his doctorate) to nutrition and food science.

# XXI
## Humanities

**Samuel W. Allen,** Professor of English at Boston University, was Visiting Professor of Literature, part time, for the fall term, teaching a course in black literature in America. He's a graduate of Fisk University and Harvard Law School and is known as the author of several books of modern poetry.

After two years as Assistant Professor of English at Earlham College and one year as Visiting Fellow at the University of Kent, Canterbury, England, **Stephen J. Tapscott** is now Assistant Professor of English at M.I.T. Dr. Tapscott's degrees are from the University of Notre Dame (A.B. 1970) and Cornell (Ph.D. 1976), and his essays and poems have appeared in several periodicals.

### Geology from Rogers to Green: A Meticulous History of the First 100 Years

One of William Barton Rogers' last papers, written before his ten-year struggle to establish an institute of technology in Boston, was "On the Primordial Fauna and the Taconic System" (in the *Proceedings of the Boston Society for Natural History*). He could hardly have imagined that a century later there would come from the institution which he was struggling to found a paper on "Seismic Data from Man-Made Impacts on the Moon" (Frank Press, G. V. Latham, et al, in *Science*).

The definitive account of that 100-year history of the earth sciences at M.I.T. has been a gleam in the eye of Robert R. Shrock, Professor of Geology, Emeritus, since before his retirement as Head of the Department in 1965. The first half was realized this fall with publication, by the M.I.T. Press, of the first volume of *Geology at M.I.T. 1865-1965 — The Faculty and Supporting Staff* ($25.00). A second volume on departmental operations — "what goes on: how students get recruited, buildings built, and faculty hired," as Professor Shrock describes it — is still being written.

Professor Shrock's first volume is a meticulous recording of personal and professional data on every member of the Department since the Institute's founder became the first Professor of Physics and Geology. There is more color between the lines than in them, often no more than a hint of the color in the history that is so carefully chronicled. Waldemar Lindgren, whose preeminent leadership of the Department lasted more than 25 years, describes his first view of the frontier West as an immigrant from Sweden: Diamond City, in the Montana Territory, is ". . . a row of 30 small shacks inclined in different directions with a general store and a saloon." Professor Frederic H. Lahee describes the pragmatic interests of his students in the beginning course in geology in 1916: "When the rustling (in the classroom) was noticeable, I would throw in a description of a practical application, and at once the room became as quiet as a tomb."

And Professor Shrock himself described as "the single greatest event" of his tenure as Department Head the visit of Cecil H. Green, '23, in 1949. It was Dr. Green's first visit to his alma mater in 25 years, and he came to recruit students for his new company, Geophysical Services, Inc., of Dallas, Texas.

Dr. Green had "no success" in the department from which he graduated — electrical engineering, writes Professor Shrock. But then he came over to the Department of Geology, which had just been moved from the Institute's main buildings into inadequate space in "the back lot" — Building 24, built for the Radiation Laboratory during World War II. There Dr. Green found a warm reception: a dozen or more students looking for summer employment, within a year an invitation to join the Visiting Committee for the Department, and a new vision for the future of the earth sciences at M.I.T. A decade later came Dr. Green's gifts for construction of the Green Building, whose completion marked the start of "probably the most exciting and productive decade for the earth sciences at M.I.T.," writes Professor Shrock.

*Throughout his career as a geologist, Professor Robert R. Shrock (left, with Mrs. Shrock) had one frustrated ambition: to be a bookmaker. Now he's done it — with the publication of the first volume of his* Geology at M.I.T. 1865-1965 *(M.I.T. Press, $25.00). Because of the effective collaboration of Professor Shrock and Charles V. Mahlmann, S.M. '53, who completed typesetting and layout, "all we had to do was add a copyright page," said Frank Urbanowski (right), Director of the M.I.T. Press, at a reception on the day of publication. (Photo: Calvin Campbell)*

# ALUMNI TRAVEL PROGRAM 1978-79

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

**AEGEAN ADVENTURE — 23 Days:** The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

**MEDITERRANEAN ODYSSEY — 22 Days:** An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

**VALLEY OF THE NILE — 17 Days:** A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

**THE ORIENT — 29 Days:** A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

**BEYOND THE JAVA SEA — 32 Days:** A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

**MOGHUL ADVENTURE — 30 Days:** The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

**SOUTH AMERICA — 28 Days:** An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

**THE SOUTH PACIFIC — 28 Days:** An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

**EAST AFRICA — 21 Days:** A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

*Prices range from $2,295 to $3,575 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:*

**ALUMNI FLIGHTS ABROAD**

White Plains Plaza, One North Broadway, White Plains, N.Y. 10601

# 03

One of our distinguished classmates has passed away. Dr. **Robert J. King**, Chairman of King Industries in Norwalk, Conn., died October 30, 1977 at the age of 95.

After graduation Dr. King worked for Merrimac Chemical Co., later to become Monsanto Chemical Co. He was chief chemist and superintendent of production for Merrimac.

From 1912 to 1915 he worked with Thomas A. Edison in West Orange, N.J., and later teamed up with Dr. George Bradshaw to establish the American Synthetic Color Co.

Dr. King's interest in sulfonic acids led to a lifelong occupation of developing practical applications for them in the production of synthetic and natural rubber. Products from his research are presently sold worldwide.

Dr. King was chairman for several years of the board of Piedmont College, Georgia, and also served as chairman of the Western Connecticut Branch of the American Chemical Society.

He is survived by his wife, Lavinia, a son and a daughter, five grandchildren and eight great-grandchildren. — **John J. A. Nolan**, Secretary, 13 Linden Ave., Somerville, Mass. 02143

# 09

Very sadly I must report the death of your Class Secretary, **Chester Dawes**, on November 4, 1977. He was a faithful contributor as Class Secretary and participated in Institute activities up to the time of his death. His grandson-in-law, Richard Phillips of the Class of 1962, wished to share the following warm remembrance of Chester with the Class of 1909.

"A successful operation for removal of blood clots from your secretary's legs proved too great a strain for his heart. He died in the hospital in Winchester, Mass., the town where he and his wife Muriel lived since 1952. Although he would have been 91 the following week, Chester Dawes still led an active life so his death was unexpected and this news is sad to relate.

"Always interested in the Institute, Chester served as class secretary for the past 35 years. Most recently he was chosen to serve on the Alumni Council and attended the Alumni Officers' Conference in October. To those of you who knew him as a classmate and through these notes, the following will seem a brief summary of a long and interesting career.

"Known variously as great-grampy, grandfather, father and 'the professor,' Chester Dawes was born in Somerville in 1886, one of eight children. Too light to play football at Somerville High School, he was proud to have played end on the M.I.T. team. (Back then there was one.) During his student years he worked on the M.T.A. After graduation he taught at M.I.T., and then beginning in 1911, at Harvard in the electrical engineering department. He specialized in power transmission and was easily able to 'snow' this grandson-in-law (Course VIII) with explanations of negative resistances and harmonic excitation in high-voltage transformers.

"During his years at Harvard he consulted for Simplex Wire and Cable, Doble Engineering and General Electric. To the ten of us in the family who were two generations younger, his stories of the early days of electricity were fascinating. He knew Steinmetz. He remembered when electric clocks were invented and how it became incumbent on the utilities to maintain an accurate 60 Hz a.c. frequency. Knowledgeable in electrical measurements he told stories of patent battles over invention of test equipment. Chester himself was inventor of the peak to peak voltmeter and of the high-heat mica plate used in electric toasters.

"He wrote two texts: *A Course of Electrical Engineering* and *Industrial Electricity*, and he wrote the electrical engineering section of *Mark's Handbook for Mechanical Engineers*. Even recently he would receive letters asking for further explanation or for answers to problems given in the texts.

"During World War I, Chester taught electronics at the U.S. Naval Academy in Annapolis, and during World War II, he headed a Harvard program teaching electronics to servicemen.

"Chester was generous with family, friends and students, and his daughter, Jane (McClennan) could not have been too surprised on coming home from college to find her room in their North Cambridge house occupied by one deserving student or another. 'The professor' maintained a long correspondence with a number of these students.

"In 1953, Professor Dawes retired from Harvard as associate professor emeritus. He held honorary degrees from Harvard and Northeastern. He continued to work as director and consultant to Doble Engineering of Watertown until his death, and he maintained an office at Harvard for a number of years following his retirement. He delighted in having three birthday celebrations every year, one at Harvard, one at Doble and one with his family. The professor was a great fan of 'who dunnits,' and as consultant for Doble he combined this interest with his knowledge of electricity to sleuth-out the chain of events leading, for example, to transformer failures.

"From 1938 to 1940, he was Vice President of the American Institute of Electrical Engineers. He was a deacon in the North Congregational Church in Cambridge and served as trustee for the North Avenue Savings Bank. Quoting from his sister Hazel's tribute on his 85th birthday: 'He has *electrified* us all with his boundless energy, never showing *high tension* or ever having to *recharge* his *batteries*. Always on the *beam*, his ever-*current phase* of humor *generates* laughter, and no matter what he is asked to do he always *retorts "I conduit,"* whether at *ohm* or elsewhere.' We all miss him." — *S.F.*

# 11

**William H. Coburn** writes that he is still active in business as an investment counsel and is living in with his wife in Westport, Conn. He is also busy managing accounts, collecting antiques and keeping up with his strong interest in current world affairs. Mr. Coburn is a member of the St. Bernard Commandery KT12 in Boston, various professional societies and was recently made a member of the Legion of Honor of the American Institute of Mining, Metallurgical and Petroleum Engineers.

**Irving W. Wilson**, the distinguished alumnus who help build the Aluminum Company of America into a billion-dollar business and served as its top executive in the 1950s, died on October 16, 1977. Mr. Wilson's thesis at M.I.T. was on the smelting of aluminum. It interested the president of Alcoa and landed him his first position at that company in Alcoa's department of plant control and engineering in Niagara, N.Y.

But Mr. Wilson had doubts about his career in the aluminum industry. It was already a $27-million-a-year enterprise and he feared it had reached its zenith.

"I figured I had missed the boat," he once confessed. "I wanted to be with a growing concern and was only sorry that I hadn't been able to join Alcoa in its greatest era of expansion."

"The tremendous proliferation of the aluminum industry over a half-century, and Alcoa's key role in that expansion, were to a very considerable degree Mr. Wilson's single-minded accomplishment," said a *New York Times* obituary.

And so in the 1960s, when the company's sales were $1 billion a year and Mr. Wilson was chairman of its finance committe, he revoked all earlier pessimism. "We are just beginning to develop markets and serve them," he said. "In 1911 we didn't visualize the airplane, multicolored aluminum, or the increasing uses of aluminum in many forms."

He became Alcoa's youngest general officer when he was elected vice president in charge of operation at the age of 41. But his busiest years were during World War II, when he guided the compnay's $300 million investment in expansion and oversaw the Defense Plant Corporation's $450-million building program. For this he received a Presidential Citation in 1948 for "meritorious conduct in aid of the war effort."

With the six-fold increase in aluminum plant capacity during the war, many predicted a post-war decline. Mr. Wilson, on the other hand, insisted that markets for the product could be sustained and enlarged. He was right. Demand for aluminum exceeded supply in 1946.

He was honored with a Doctor of Laws degree from the University of Pittsburgh, and Washington and Jefferson College, and a doctorate of commercial science from Dusquesne University. He was a member of the M.I.T. Corporation and the Alumni Association honored him for his contributions to the Institute. In addition he was a trustee of the National Industrial Conference Board and a director of the Mellon National Bank and Trust Company. — *S.F.*

# 12

**Rock Comstock** is very much up-in-arms about doings or lack of doings in Washington, especially about the Canal treaty. He has a two-column article in his local newspaper and has written his congressmen. He is considering adopting a pen name such as "Tom Paine the Second," recalling the fact that the original Tom agitated for freedom, while the second Tom would agitate for the preservation of our liberty.

**Harold Brackett** is back home in New Jersey. His health is steadily improving. His main gripe at this time is his salt-free diet, about which we can sympathize with him.

I regret very much having to report the death of **Bob Stobert** on September 6, 1977.

The Alumni Office tells me that more than half of the Alumni Fund subscriptions needed for the Class of 1912 Building 10 Chair in the new Huntington Hall (Room 10-250) has been received. Simply designate your gift to the Class of 1912 Building 10 Chair on your Alumni Fund envelope if you want to join in. All contributors to the Building 10 project will have their names inscribed on a plaque in the Building 10 Alumni Center. Also, any pledge or gift which represents at least a $25 increase over last year's gift will receive Challenge gift credit. Challenge money earned will not go to the Chair but will be credited to the general Building 10 Fund.

Please do not forget that it is the information and notes which you send in which keep this column going. — **Larry Cummings**, Secretary, RR 4, Connersville, Ind. 47331

# 13

We were sorry not to be able to attend the Alumni Officers Conference on October 10 due to frequent attacks of arthritis.

We sent out 73 bills for the 1977-78 Class Dues, and have received 34 returns. Two envelopes were returned by the Post Office, which had no forwarding addresses for **Arthur Kenney** and **Joseph N. Paul**. If anyone has any up-to-date information on these two classmates, please let us know.

**Charlotte Sage** wrote on September 10: "How has this weather — crazy summer — gone with you? I hope well and that you are properly insulated! It was the busiest here I've ever known with cousins, etc., by the dozens. I'll be staying on mostly alone to clean up, close up, and enjoy the autumn, but plan now to attend the Alumni Officers lunch on October 10. We are a small class without those millionaires, but still we can be represented and now M.I.T. is out for more women; it's O.K. with me."

**Fred Lane** writes: "We are going on about as usual. I am trying to keep in shape for the 1978 Class of '13 reunion, but am not confident I can make it. Those of us 1913ers who are left are no longer kids who can go anywhere they wish. But we'll hope for the best."

**Herbert G. Shaw** writes: "We are well, but Leila is troubled with two lame knees. She manages around the house but uses a cane for all outside walking, and walks as little as necessary. I am still active with the S.C.O.R.E. counsel board, and I find it very interesting, and gain valuable information concerning so many new business ventures. I now have a new toy or hobby. Recently I was given five old mechanical calculators that run on electric power: two Friden and three Monroe machines. They all worked but one of the Fridens, which I have taken apart. I have manuals for the others, and I am having fun finding out how much they can do. These machines were made obsolete along with slide rules by the new electronic calculators. I still have the slide rule that I bought at McLachlan's so long ago. I can understand why electronic calculators have replaced these machines, as I have two of those, as well. The others are all for the pleasure I get out of them, and keep my mind active. In addition, my longtime hobby is collecting antique clocks and watches. We do not expect to be at the next reunion, as our traveling days are over. We are fortunate that we can enjoy staying home."

We received word of the following deaths: **Henry C. Thierfelder** on February 2, **Arthur E. Hirst** on September 19, **Lloyd A. Hechinger** on October 27, and **Allison Butts** on June 30. We have sent sympathy cards, and if we receive more information, we will publish it later.

We trust that you all have had a most merry Christmas and that 1978 will be a good and healthy new year. — **George Philip Capen**, Secretary and Treasurer; **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, Me. 04005

# 14

An article, "Great Businessmen," in the September issue of *Forbes* magazine said: "Commercial aviation worldwide was virtually built around **Donald W. Douglas**' DC-3. In World War II his company, founded in back of a Santa Monica barbershop, built more planes than Germany and Japan combined. For a generation he dominated the airlines field."

In an October letter **Ray Dinsmore** wrote: "I am feeling O.K. Of course I have my good days and my bad ones, but I am able to get around, go out to dinner occasionally, and do some walking. The countryside is beautiful this week. The fall colorings are at their best, but too soon the leaves will be all down, and winter will be upon us." . . . The San Antonio Art Institute held a four-week exhibition of **Alden Waitt**'s landscapes last October and November. Alden told me the press comments were so favorable he didn't feel he should let me have them.

**E. Mortimer Newlin** died in a hospital near his home in Wayne, Penn., on September 1, 1977, at the age of 84. He was with us in all four years and received his bachelor's degree in Course VI. In World War I he was captain of a machine gun company and was wounded in France. After some years with Minneapolis General Electric Co. he entered the investment securities business in Philadelphia, first with Goodwin, Newlin and Co., and later with H. M. Byllesby and Co., of which he was Vice President when he retired in 1960. Mort had been a director of Duquesne Light Co. in Pittsburgh, White Motor Co., Robbins and Meyers, and other corporations, and had been President of the Pennsylvania Working Home for the Blind. He was a member of the Racquet Club of Philadelphia and a former member of the Bond Club of that city. He had long given most generously to the M.I.T. Alumni Fund, and had established trusts so that his benefactions to that and a substantial number of other good causes will be continued. Mort's philanthropies included the establishment of the Nathaniel Newlin Grist Mill Park, 125 acres of woods and meadows near Media, Penn., opened in 1959. He is survived by his wife of 48 years, the former Elizabeth Bell Battles; a son, William VerPlanck Newlin; a daughter, Mrs. Peter H. Sellers; a sister, and eight grandchildren.

Word has come from the Alumni Association of the deaths of **Harold J. Coleman** on December 12, 1976; and **Ernest W. Mann** on September 19, 1977. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

# 15

A bright and successful new year to all you classmates and your families with the hope that you enjoyed a healthy and happy holiday season.

Graduating from a wheelchair to a single cane is great progress for me. However, I probably couldn't do the "hundred" in ten seconds. Again my thanks to you all — classmates, families, and friends of the Class — for your many kind messages. They all really cheered and helped me a lot.

Cheerful and generous **Wayne Bradley** spends a night each week with me. He's good company — a great guy.

**Alton (the Old Woof) Cook** has been enjoying the Florida sunshine a little earlier than the other "Snow Birds." Wayne will join him down there later.

**Carl Wood** has been civil defense director for the town of Peterboro, N.H., for ten years and has been an advisory engineer to the town engineering department; he still finds time to bowl on the green.

I talked with **Jim Tobey** in Rye, N.Y., looking for some professional help on my stroke situation. Jim is healthy and busy.

**Ellis Ellicott** wrote me a splendid letter. In July with a group of five friends he went fishing at Reindeer Lake, northern Saskatchewan. He said it was really wild with only three camps on a lake 200 miles long. Then in September he fished the French River about 300 miles north of Toronto. In between he said he played some golf. He's a real athlete for our age group.

I hope my return to good health soon will put me in shape for our annual class cocktail party and dinner on Alumni Day in June. There are fewer and fewer of us, but this get-to-gether means a lot to us.

**George P. Elliott** died in Amesbury, Mass., on May 14, 1977.

Write when you can. I'll always be glad to know how you are and what you're doing. In the meantime, all the best to you and your familes. — **Azel Mack**, Secretary, 100 Memorial Dr., Apt 214C, Cambridge, Mass. 02139

# 16

We begin a new year. May it bring good health and happiness for our classmates and their families.

**Shatswell Ober** wrote in October: "I do not have any good printable news to offer. I live in one place year round with my sister; mow a small lawn; bag many leaves; shovel a little snow; pay taxes; support with trifles M.I.T., church, some music."

**Dave Patten** writes: "Dorothy and I regret our inability to attend this 61st event and celebrate with our fellow octogenarians. We were recovering from a ransacking along with some 20 others in this otherwise staid old village." . . . **George Crowell** sent us a newspaper article and clipping which covered a meeting of the Brockton Massachusetts Kiwanis Club at which George was presented a 55-year pin as the oldest and only living charter member of the club.

**Charlie Reed** writes that he wished he and Mildred could have been with us for our 61st and continues: "Mil and I spent most of June and all of July, August, and September at our summer home in Wayne, Me., on the great sand beach of Androscoggin Lake. All my three sons now have a house in Wayne, two on Androscoggin Lake and Charles, Jr., on Pocasset Lake. There is something 'catching' about Wayne. Whenever one has visitors they try to find a home there and in many cases have subsequently moved to the town and raised families there. So we have many friends who love the beautiful little town as we do."

From **Ken Sully**: "Emerald and I play shuffleboard and are captains of teams and in a group who won trophies in playoffs. Our best wishes to all for your good health and happiness."

**Art Shuey** pleased us with this report: "**Vertrees Young** and I and our wives went to the M.I.T. Alumni Summer College in Aspen and had a most interesting and enjoyable week with fellow alumni and the smartest professors I ever saw from M.I.T. After a week of poor trout fishing in Colorado I came home to the hospital to find what was wrong besides 85 years: nothing serious — low-grade pernicious anemia. At any rate Mildred and I sailed October 1 to the total solar eclipse on the *T.S.S. Fairwind*. It was our third eclipse cruise and we took neither telescopes nor cameras and just enjoyed every bit of the 151 seconds of totality on October 12 in mid-Pacific. Thanks for the group photo; most of our classmates look younger than I feel."

We regret to report the passing of our good friend and classmate **Charlie Lawrance** on November 5. Charlie was one of our most faithful reunion attendants. He attended almost every reunion since the 35th and most recently our 61st. It was

always a joy to see him coming toward the front door of Cottage "G" at Chatham supported by two walking canes, and then making his way down the hill to the shore for our clambake. He had an indomitable spirit and was a source of inspiration to most of us. His response to "How are you, Charlie?" was simply one word, "Hopeful." Charlie was born in Tokyo of Unitarian Missionary parents who were then stationed in Japan. A veteran of World War I, he was active in the Reserves and the State Guard. After teaching at several public schools in eastern Massachusetts he became director of schools in the Kingston-PembrokePlympton-Halifax district in 1932. He retired in 1948.

Keep breathing; and keep those letters coming. — **Ralph A. Fletcher**, Acting Secretary, Groton Rd., W. Chelmsford, Mass. 01824

# 17

The Class recently made a donation of $10,000 from its undesignated Special Project Fund to the Margaret Hutchinson Compton Fund. The purpose of the gift was to assist in the establishment of the Margaret Compton Gallery which is a part of the new Alumni Center in Building 10. The Gallery consists of beautifully reproduced pictures taken during Dr. Compton's administration. They depict many of his family activities, as well as those of distinguished visitors to M.I.T. during that period. Gracious acknowledgement of our gift has been received from Maureen Feldman, Chairman of the M.I.T. Women's League.

I am sorry to report that **John Holton** suffered a rather painful illness last August. A recent note from him says that although he is up and about, he still suffers because of the pain in his eyes. This limits him very much in his reading and TV watching. However, he and Sally look forward to a Florida visit during the winter, and in the spring are to move to their retirement home in Pennsylvania.

A note from **Ray Stevens** reports he recently had a splendid visit with **Joe Littlefield**. Joe was with his family at Annisquam, Mass. He came to Cambridge to meet his son, Joshua, how a freshman at M.I.T. Joe lives in Coral Gables, Fla., all year round and claims it is a great place to live, although hot in the summer (a maximum of 94 F) but tempered by regular breezes off the water. Joe's son, Paul, is with Arthur D. Little, Inc., and has a home in Annisquam; hence, Joe's visit there.

**Dick Loengard** reports on the activities of the 1916/1917 luncheon meetings in New York. At the October meeting, '17 was represented by **Enos Curtin**, **Bill Neuberg**, **Clarence Seely**, and Dick. Walter Binger represented 1916. At the November meeting, Bill Neuberg, Clarence Seely, and Dick represented 1917, while Walt Binger, Rudy Gerber, and Charlie McCarthy represented 1916. Dick would appreciate it if more from the New Jersey, New York and Fairfield County areas would attend these meetings, which, he says, are for octogenerians with a youthful point of view. However, do let Dick know in advance if you plan to come to a meeting.

Pat and **Bob Erb** had a marvelous tour starting September 15. They flew to Rome. There they boarded the cruise ship *Argonaut* at Civitavecchia, cruised the Tyrrhenian Sea to Palermo, through the Strait of Messina to the Adriatic. They made several port stops including Venice, then sailed along the coast of Yugoslavia, visiting Korcula, Dubrovnik, and Kotov. Next was the Ionian Sea to Greece, where they visited Olympia, Delphi, and Athens. From Athens they flew home to New York. Bob recommends the trip highly. It sure sounds great.

Christine and **Walter Beadle** are staying put this winter in Kennett Square, except perhaps for a couple of weeks in February when they may go to Stratton Mt., Vt, for a couple of weeks, so Walt can do some downhill skiing. His limited vacation this winter is due to his responsibilities as President of the Kendal Residents' Association, which has 350 members and 30 very active committees. He finds it a challenging and worthwhile job.

The **Dunhams** and **Dunnings** recently visited the **Les Fords** at their 1715 home in Marion, Mass. They found Les was busy using his architectural skills on a renewal project of the City of New Bedford. This is the "Project Whale" for the development of a ten-acre section of the "Historic Waterfront Area" near to the famous Whaling Museum. . . . A note from **Ray Brooks** says how much he enjoyed the 60th Reunion at the Pops concert and the luncheon at Endicott House. He only regrets he was not able to be with us at Chatham Bars Inn. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

# 18

Every once in a while it happens to all secretaries — and this time to me. There is a dearth of news. So I must be ingenious. With apologies to all of you, I include news of some of the things I am doing in the M.I.T. family.

A little over a year ago, I became involved in a program for alumni and their wives (or vice versa). The format was a series of six lectures spaced a month apart by M.I.T. professors studying the social problems of the community. Following a dinner, the speaker outlined his contribution in his particular expertise — and then the bull session of questions and answers took place. A group of 24 alumni became interested students — the whole experience was considered a great success by its participants. A dividend for the M.I.T. Alumni Association was the active involvement of new faces in its activities.

This year a new seminar series has started in October. This one is titled "M.I.T. Looks At The Eighties." We have neary 50 members and the enthusiasm is high. The initial session, addressed by Professor Lincoln P. Bloomfield on "Global Politics," was an outstanding performance enjoyed by all.

Last week I saw Elinor and **John Kilduff** off to Florida where they plan to stay until March. John has made a good recovery from his setback due to a fall which caused a head injury. We expect that his stay in Florida will be most beneficial. We look forward to our get-together with him and all of you at our 60th Reunion in Cambridge in June. Last week I saw Gladys and **Lou Levine** — both of whom are fine. They plan to spend two months of the winter in Florida. I also had dinner with Dolly and **Eli Berman** at a recent Boston Club meeting. They are looking forward to spending January and February in West Palm Beach.

A card from **Mel Baber** reports that Jean and he are spending November at Hilton Head Island, South Carolina, and then back to Philadelphia for December and January. I was indeed touched to receive a card from Frances and **Pete Harrall** who did some fancy detective work to find out my birthday.

I regret to report the passing of **Grover Slator** on July 6, 1977 and **George Brewer** on September 16, 1977. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine**, Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

# 19

**Paul Blye** writes on October 11: "I have just read the Bell Lab news of the passing on September 8 of **Pat Paterson**. As you know he was a loyal classmate and a close personal friend of mine for many years. Pat achieved a Bell System-wide, indeed an international, reputation for his expertise in the field of quality assurance. He made literally a host of friends at the Labs and was highly thought of in top management circles. A real good guy."

Pat's wife wrote and sent some local newspaper reports and tributes. A column in the *Eastchester* (N.Y.) *Record* on September 15, 1977, "On the Death of a Friend," said many things about Pat. "His community concern was felt on all levels in the schools, government, church, hospital, arts, culture, and home. His multiple services to the community did not go unnoticed as he was the recipient of the 'Red Feather Award' of the Community Fund and the Man of the Year honor from the Eastchester Chamber of Commerce. Pat was born December 10, 1898 on Prince Edward Island, Canada, and for the past 50 years lived in Eastchester. He held a Master of Business Administration degree from New York University. He is survived by wife, the former Ethelind Munroe, two sons, Donald of Ithaca, N.Y., and Alan of Columbus, Ohio." Pat was one of the editors of our 25-year book and all members enjoyed the times we had with him at that time.

**Jim Holt**'s death was mentioned last month thanks to a note from **George Michelson** but the rest is presented here. James Holt was age 80, a native of Somerset, Mass. He returned to M.I.T. as a teaching assistant after his army service, and there became a full professor and executive officer of the mechanical engineering department from 1941 to his retirement in 1962. During World War II he was associated with the Boston firm of Fay, Spofford, and Thorndike designing army bases. He was active in mechanical engineering societies, a member of the Duxbury Yacht Club, a life member of Pioneer Lodge AF and AM of Somerset, and a charter member past master and treasurer of Richard C. MacLauren Lodge of Cambridge. He leaves his wife, the former Martha Cotterly; two sons, James of Denver, Colo., and Laurence of Boxford, Mass.; and a sister, Mrs. Susannah Lawton of Somerset.

**James W. Reis** still has been finding his travels of interest. His letter of October 11: "This spring I went back to the Orient — mostly Korea, North Thailand, and Burma — with my sister. I found Burma very interesting in spite of the frustration of traveling in a completely communistic dominated country, which was very different from my travels there 20 years ago. Unfortunately, I got completely exhausted physically and that coupled with a long tiresome flight from Hong Kong to Los Angeles was a little too much. I had a slight heart attack the day after I got back to Los Angeles. Fortunately there doesn't seem to be any permanent damage and a month of complete rest with my sister in western Pennsylvania and a two-weeks cruise to Alaska has put me back in pretty good shape. From now on no back country trips. I'll be in Pennsylvania for Thanksgiving and Los Angeles after that. If you or any classmates are passing through this way I will be very happy if they will look me up. Hope this finds you all well and healthy."

**Edward Adams Richardson** has emphysema and must use oxygen so he gets out very little. He is dependent on his wife Mary. Reading is his principal occupation. Otherwise there is little to report. He has been retired more than 15 years. He sends his regards and best wishes to all from Apt. 2, 53 E. Market St., Bethlehem, Penn. 18018.

**Walter C. Roberts** of 65 Summer St., Weymouth, Mass. 02188 writes: "I am sorry that I haven't much news as I am crippled with arthritis of the knees and very seldom leave the house. My son John, a graduate of Cinncinnati University, has retired from government service where he had charge of naval procurement and testing and opened an office in Washington as agent for a computer company. He has also just become a grandfather. That makes five great-grandchildren for me. I have just passed my 80th birthday and my age is showing."

**Frederick C. Spooner**, Box 2, Lincoln, Mass. 01773 — "You are an alert and faithful class secretary, God bless you. My wife Sarah and I are in our eighties. We have given up skiing. Otherwise our health is very good. We associate with many M.I.T. families here in Lincoln as well as at our interesting island in Lake Winnepesaukee, N.H. Five Tech families there."

**John Stevens**, 339 Lake Rd., Menasha, Wisc., 54952: "Your card arrived as I was in the midst of packing for our annual migration to Florida for the winter. Expect to be there on November 21. All is well here at the moment and I am told that my health problems are about average for one of my age. What the situation will be at the time of our 60th I cannot predict but at 83 I should feel as good as I do today. Am no good at traveling — in fact, I dislike it, but I still look forward to 1979 with confidence. Hope I will be reasonably mobile at the time."

Your secretary visited Lahey Clinic, Deaconess Hospital and the hospital here during the past two months for heart, blood and a swollen nasal polyp. All part of approaching age 80. — **E.R. Smoley**, Secretary, 50 East Rd., Apt. 11E, Delray Beach, Fla. 33444

# 20

Your secretary's precious notes for this issue were lost, so, rather than miss an issue, he will try to reconstruct them from an admittedly dim recollection. I recall citing the Class for its liveliness. Gladys and **Foster Doane** completed the latest of several trips with the M.I.T. 25-Year Club, this one to Asia Minor where Foster visited a paper mill, he being a world-famed authority on pulp and paper making. **Warren Chaffin** and his bride sailed around the Continent from New York through the Canal and way around to San Francisco. Ann and **Bink Carleton** reported on a very pleasant visit with Denise and **K. B. White** in their lovely castle near Paris. Hannah and **Harry Kahn** have made extensive travels to lend expertise on the manufacture of ceramics in behalf of the U.S. government.

A warm and gracious letter from Page **Fales** comments on **Herb**'s very meaningful relationship with M.I.T. "It has always been with a great sense of pride that he has spoken of his connections from the days when they were within the Institute and then continuing through the years." Page mentions talking with Margaret **Brown**, wife of our beloved **Skeetz**, and says she has moved to El Paso to be near her grandchildren and newly arrived great-grandchild.

I do recall wishing you all a happy and healthful New Year and hoping to hear from you. As the Chinese say, "May you live in interesting times." We certainly do. We certainly do! — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

# 21

A postcard from Tel Aviv in September from Dorothy (Mrs. **Joseph**) **Wenick** tells of her trip to Israel. "This country is magnificent — flowers and trees in bloom where once there was only arid soil and rocks. Here the Bible comes alive. Miracles have been performed in the space of a very few years. Will stop to see Martin in Rome on the way home."

**Irving Jakobson** sent me a report on the Alumni Officers Conference held on October 7-8. "Classmates in attendance were Win and **Royal Wood**, **Don Morse** and myself. The rebuilt lecture room, 10-250, was the scene of most meetings — nicely done, comfortable chairs, upholstered in a startling shade of purple which really blended nicely into the decor. I am suggesting in the Class President's letter that Alumni Fund contributions be made towards chairs in 10-250. We were entertained Friday night by the 'Logarhythms' and the M.I.T. Concert Band."

Three more "life histories" sent to Assistant Secretary **Sam Lunden** in response to his request, are herewith put into print this month. Space requires that these be condensed somewhat. Brigadier General **Ludson D. Worsham** wrote "I had so many challenging assignments in the Corps of Engineers and as a Vice President of Ralph M. Parsons Co., that it is difficult to pick out the highlights. I'll give it a try. From 1921 to 1925 I was an instructor at U.S.M.A.; 1925 to 1932 I was an Assistant District Engineer, working in flood control, power, and navigation for Mississippi and Arkansas Rivers; 1936 to 1940 I was an Instructor and student commandor at Forts Leavenworth and Belvoir; 1940 to 1942 I was a District Engineer at Pittsburgh and Mobile (mostly airfield construction); 1942 — Division Engineer, Great Lakes Division (airplane assembly plants and ammunition factories); 1942 to 1943 — Division Engineer and Commanding General, Northwest Service Division (supervising the completion of the Alaskan Highway, developing oil fields, the 600-mile pipeline across Mackenzie Range, and the refinery at White Horse).

"In 1944 I was Assistant Chief of Engineers for Military Operations, Washington, D.C. (overseas operations); 1945 — Chief Engineer, Armed Forces, Western Pacific; 1946 to 1948 — Division Engineer, Western Ocean Division, including Honolulu, Suam, Okinawa, and Manila. Due to a heart attack, I retired from the army in 1948 and in 1949 I began working for Ralph M. Parsons Co. until 1961. Awards: A.S.M., Legion of Merit, Oak Leaf Cluster, Order of British Empire." The class salutes General Worsham.

**Roy A. Wehe** of San Mateo, Calif., writes of an interesting career, largely in public service. Roy got a degree at the University of North Dakota in 1918, was an Ensign in the U.S. Navy from 1918-19. He entered M.I.T. in 1919 and got his S.B. degree in Course XV in 1921. Career chronology: 1921 to 1923 — Field Cost Engineer, Southern California Edison; 1923 to 1948 — Engineer and Director, California Public Utilities Commission, including seven years as Chief of Gas and Electric Division (valuation, appraisal, examiner); 1948 to 1977 — Self-employed management consultant — public utilities, municipal corporations, government agencies, and industry.

Roy had a long list of special assignments which included cost-allocation analyses of the water and power project at Shasta Dam; World War II studies of power supply, security and rates for military installations in California; work with the Federal Power Commission in 1947 on nationwide natural gas layout; Technical Adviser to the Allied Military Government in Germany on postwar utility rehabilitation in Germany and Austria; assistance in rate case for Public Utilities Commission of Hawaii; cost analyses and financial forcasts for water systems in Tucson and Phoenix, and for power and water development at Hetch Hetchy Dam. In addition to all this, Roy found time to be Councilman and Vice Mayor of San Mateo (1946 to 1950) and recently as Public Works Commissioner for San Mateo. He and his wife Grace have traveled extensively over the years to Canada, Hawaii, and Europe. When Roy wrote Sam Lunden last May he said he had "closed shop now" having just come home from the hospital after a close call from heart failure. Your Secretary recalls with pleasure a luncheon date several years ago when Roy and Grace were hosts to **Grant Miner** and me. We hope all is well with the Wehes.

The last letter to Sam Lunden quoted this month is from **Decker McAllister** of Hillsborough, Calif. He writes, "I guess the best thing is to send you a reproduction from the biographical section of the next International Yearbook. While I have been involved in minor pro bona publico money-raising boards, my most fun was a 17-year stint on the Board of Trustees of the California Academy of Sciences including eight years as Chairman. The Academy in San Francisco's Golden Gate Park is smaller than the American Museum of Natural History in New York but has about the same activities and as distinguished a reputation. Currently I am supposed to be retired as Honorary Chairman of the Board of the company of which I was a founder — Pacific Scientific Co. I spend three or four months a year at our vacation home in Hana, Maui." The biographical section referred to above lists some additional career items which, among others, include: Vice President, Bendix Instrument, 1935; Director, Varian Associates, 1951 — and Oxford Labs, 1960; Vice Chairman Oxford Labs; Arthritic Foundation.

It is my sad duty to report four more deaths this month: **Oliver L. Bardes** of Cincinnati, Ohio, on October 13, 1977; **Louis L. Lesser** of Seattle, Wash., on September 29, 1977; **Marshall G. Munce** of York, Penn., on October 15, 1977; and **William M. Stratford** of Rancho Santa Fe, Calif., in February, 1977.

**Ollie Bardes,** track star at M.I.T., spent his entire business career with Bardes Industries of Cincinnati. The Bardes Corporation, of which he was President, manufactured electric connectors, tools, drilling equipment, et al. Ollie built the Bardmoor Country Club in Florida where our class had a mini-reunion a few years ago. He loved golf and played in this country and abroad. He was a member of many clubs and held numerous directorships. I am indebted to **Helier Rodriguez** and **Wallace Adams** for information on Bardes.

Lieutenant Colonel **Louis Lesser** entered the Army in 1921 and attended its Command and General Staff at Fort Leavenworth, Kansas. He retired from the Army in 1944. Subsequently he was employed by Eastman Kodak and Anderson Kodak in Seattle until 1964.

**Marshall Munce** graduated from V.M.I. in 1917 and was a veteran of World War I. He worked for York Corporation for many years and retired as Vice President in 1957. Subsequently he was a management consultant until 1970.

**William Stratford** was President of Texaco Development Corporation for many years.

The sympathy of the class is extended to the families fo these classmates. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

# 22

Our letters from Class President **Parke Appel** and contribution reminder with accompanying pledge card caused us to write a check, then to think back to last June 11 when we enjoyed our Class meeting in McCormick Hall. Madeline Appel has thanked us for the silver tray. The movies shown to replace our scenic bus tour again proved that **Bill Elmer** is a great entertainer. We were shown a review of our 45th Reunion at the Wiano Club on the Cape and our graduation pictures — including the storm-tossed tent and the boat trip down the Bay to Nantasket. We saw the swimming race, tug-o-war, tub and potato races, barrel boxing, and **Chuck Brokaw** diving. **Don Carpenter** gave the Farewell Address as straw sailor hats sailed in the breeze. Dean Talbot and Acting-President Thompson responded. It was thrilling to recall those days 55 years ago. Bill Elmer was assisted in this exceptional entertainment by **Vernon Whitman**, who showed slides of *VooDoo* cartoons of 1922 by both Bill and **Chick Kane** — including drawings of the office cat, bathing girls, and corny "He and She" jokes in the Tech Show.

On reviewing our notes of experiences at the Spalding Inn Club, we were reminded of the tennis prizes to **Frank Kurtz** and **Ray Ellis**, and a golf trophy to **Saul Copelman**. We were happy that the **Ted Elliotts** of Manchester joined us at the Club.

**Marjorie Pierce** has been recognized for distinguished services with the 1977 Bronze Beaver Award. Marjorie was acknowledged as an active member and officer of M.I.T. alumnae for most of her 55 years since graduation and especially for her efforts on behalf of the Ellen Swallow Richards Professorship, an inspiration to many young women and men. . . . **Martha E. Munzer** has just completed a book to be published by Alfred Knopf in 1978, *Full Circle: Rounding Out A Life*. Martha is also teaching a course in community development for an alternative high school in Mamaroneck.

In our favorite books from the West, there is the **H. W. McCurdy** *Marine History of the Pacific Northwest 1966-1976*, the third volume of a priceless set. This one is by Gordon Newell. We can see that Mac is as busy as ever. . . . **Walter M. Saunders, Jr.**, has written from Cape Elizabeth, Me., of the good life up there. Walt notes that the Boston Patriots were trounced by the Buffalo Bills with a quarterback named Ferguson.

We thank Bill Elmer for sending us from Thornton, N.H., his booklet containing the 95 Theses which he tacked on the door at 25 Beacon St. back in 1969. He claims it was not from horseback. Bill is offering to M.I.T.'s Historical Collections a replica of Edison's first lamp, a specimen of Westinghouse's OV20 street lighting, and also the first commercial G.E. street lighting photo control. He is including a reflector he designed that was used to photograph the surface of the

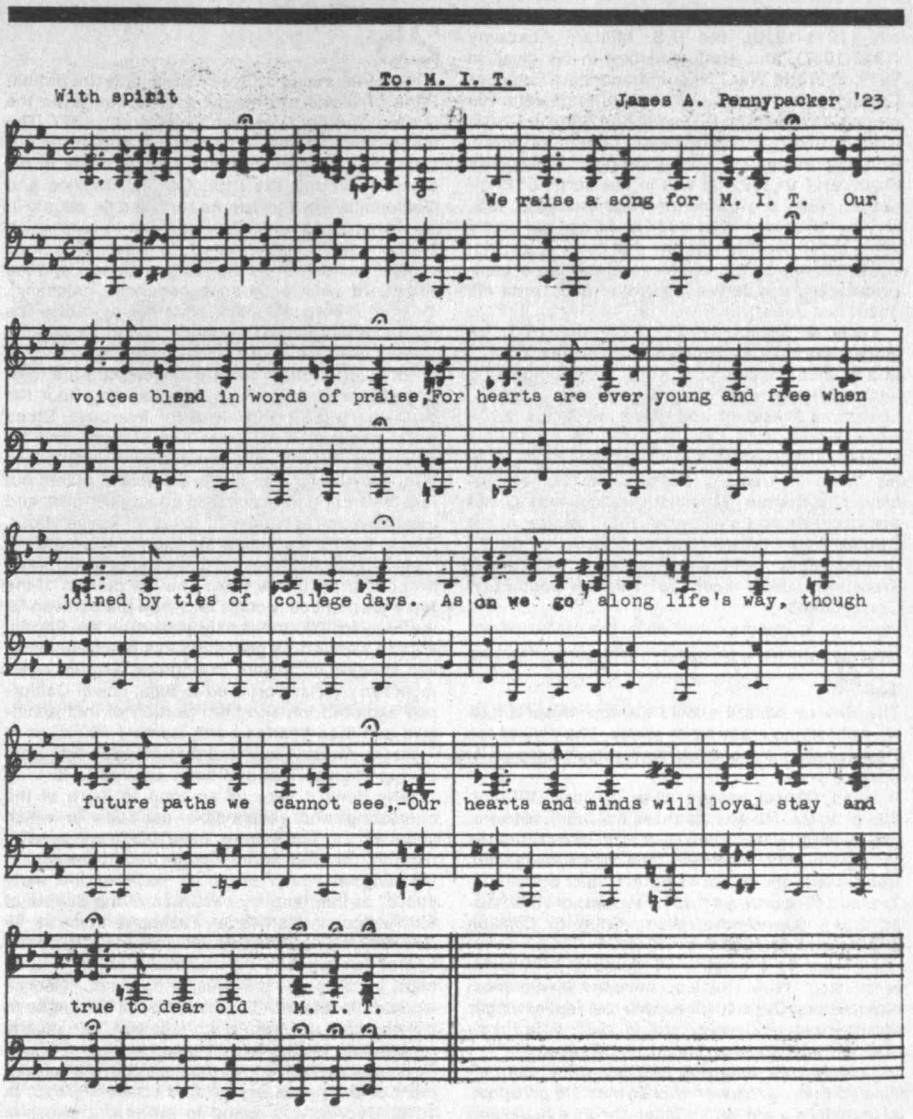
moon in color stereo on the Apollo II moon walk.

We are sorry to report the loss of **Kenneth G. Merriam** in October in Worcester, Mass. Worchester Polytechnic Institute has received a $500,000 gift to endow a dedicated professorship honoring "K.G.," who headed W.P.I.'s aeromechanics program for 30 years. Professor Merriam was cited as a dedicated teacher, a master of discipline, and a possessor of a spirited curiosity about all things technical and spiritual.

Memorial services were held for **Joseph H. Keenan** in July in Cambridge. He was an internationally recognized authority of thermodynamics and a member of the Mechanical Engineering Faculty for many years. Professor Keenan was recently elected to the National Academy of Engineering for important published textbooks and modern teaching of the mechanics of heat. He had been a Fulbright lecturer at Cambridge University and Imperial College of Sciences and Technology in England. In 1966, he was awarded an honorary doctor of laws degree by the University of Glasgow in Scotland.

The sympathy of the Class is extended to the families of **Thomas F. Williams** of Rotterdam, N.Y.; **Erb N. Ditton** of Quechee, Vt.; **Kenneth Bernard** of Arlington, Va.; **Robert N. McClellan** of East Dennis, Mass.; and **Robert J. Ballentine** of Wheaton, Ill. We also send sympathy to the family of **Bernard F. Rivkin** of Hyde Park, Mass., a retired engineer for Stone and Webster. He headed his own construction firm in Florida in the 1920s and continued for many years as project engineer for Stone and Webster. He was a past president of the Stein Club of M.I.T.

And now a word from Buffalo. We enjoyed 30 perfect days of Indian summer golfing weather in October and November — so there. A happy, cozy, comfortable New Year to all. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y., 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla., 33060




*"To M.I.T." was written for the Class of 1923 on its 50th reunion by James A. Pennypacker, its Assistant Secretary and unofficial poet laureate; since then the Class has adopted the song as its own expression of loyalty both to the author and to alma mater. Now Mr. Pennypacker proposes that "To M.I.T." deserves wider fame among M.I.T. people of all ages and classes everywhere. He advocates it as "easily singable; suitable for undergraduates* and *alumni, sons* and *daughters; and the harmonies are solid and close." In addition to the arrangement shown above, there's a version for quartet (or quintet, with optional deep bass).*

# 23

As we submit this copy (early November) over 50 classmates have indicated that they are planning to attend our 55th Reunion (June 7 to 12, 1978) and of these people over 80 per cent will also be with us on the Cape. We have been getting an excellent response and class dues have also been coming in well, even including those who for various reasons will not or cannot attend. We could well use a few more $10 class dues items as we shall not charge a registration fee to those who will attend. As a result of sending out the first bulletin we have heard from some who otherwise would not have communicated news for this column.

**Thomas B. Drew** tells us that he and Alice are moving to Glenn Dr., Route 2, Box 34, Peterborough, N.H. 03458 after Christmas, as their 40-acre place in Temple, N.H., "was getting too much for us." Both are well and entirely in good order. . . . **Harold B. Gray** sent us a "timely note" clipped from the *Wall St. Jounnal*: "Nothing makes you so aware of the passage of time as the class reunion. Unless, of course, it's being double-parked." Unfortunately Harold feels he cannot plan definitely on coming at this time. He expects to be celebrating his 84th birthday about then. Harold, we shall count on seeing you — best wishes to you! **Lowell L. Holmes** tells us that he will not be able to enjoy the reunion. He had a mild stroke on the last night of the 1975 World Series followed by a "stronger shock wave" in February, 1976. He is now ambulatory but **Ray Holden** drives him to the S.W. Florida M.I.T. Club meetings. He has enjoyed serving for some ten years as President and later Secretary-Treasurer of that Club, ending in 1974. Again, Lowell our best wishes — we hope you can find some way to make it next June!

**Bertrand A. McKittrick** has decided to move to Florida and his address there is 1180 S. Ocean Blvd., Boca Raton, Fla. 33432. He will spend summers in the North, at 63 Middlesex St., N.Chelmsford, Mass. 01863. He is our third Vice President. He looks forward to seeing many alumni at the M.I.T. Club of Palm Beach County, Fla., where **Earle Griswold** is a member. . . . Phyllis and **Dave Davenport** visited the McKittricks last winter in Boca Raton. Bert expects to see us at our 55th. . . . **Howard F. Russell** writes to us from 10026 Waikiki Dr., Sun City, Ariz. 85351. Much as he would like to be with us on our 55th, Howard tells us that his eyes are giving him trouble. We are glad to learn that his doctor tells him that he is in good shape otherwise — real good in spite of his 80 years. Hope you can find some way to make it north to our 55th Howard! We remember that you had a most fine record of attendance at previous reunions. Good luck! He says we will like the Lighthouse Inn at West Dennis. . . . **Miles N. Clair**'s wife Carolyn writes that "The plans for the 55th Reunion sound latory) will look forward to meeting for this gala occasion. As Miles has difficulty in writing I am sending this note with a check for dues." Thank you Carolyn. We look forward to seeing you both indeed!

**Edward J. Healy** passed away on September 9, 1977. Soon after graduating with us he joined The Turner Construction Company in Boston, serving in various capacities and rising to the position of Superintendent. During these years Turner built such projects as Breakers Hotel in Miami, Haddon Hall Hotel in Atlantic City, and the James River Bridge in Newport News. Later with Keystone State Construction Company as Superintendent he participated in such projects as construction of the Pennsylvania Railroad's Broad Street Station and their 30th Street Station, and allied facilities including electrification. He then joined the Kuljian Corporation, becoming Vice President in charge of their construction division involved in important projects in India, Pakistan, Thailand, Korea, Central America, Venezuela and Argentina. He was an ardent sportsman, a lover of horses, and a polo player.

**Harris Jones** died July 1, 1977. He entered M.I.T. in 1921 and received his degree in civil engineering with our class. Born in 1892 in

Torrington, Conn., he attended Harvard University (1911-1913), the U.S. Military Academy (1913-1917), and graduated first in his class in 1917. In World War I he commanded an Engineer Company and later a Battalion of Engineers. His medals included the Distinguished Service Cross, Distinguished Service Medal, Legion of Merit, Commander, and Order of Leopold II (Belgian). From 1917 to 1931 he was in the Corps of Engineers, was professor of mathematics, U.S. Military Academy, 1931-1947 and Dean of Faculty 1947-1956. He retired in that year as Brig. General. He was active in several military organizations and resided in Asheville, N.C., until his death last July.

**Louis M. Nelson** died on June 14, 1977. He graduated from the University of Illinois in 1921 and studied courses in business and engineering administration and civil engineering at M.I.T. Louis was President and Manager, North Shore Hotel, Evanston, Ill.

**Herrick O. Tappan** died on October 20, 1977, at his home in Weston, Mass., of cancer. He received his degree in mechanical engineering with our class. He was part owner and treasurer of the Daniel Cunningham Construction Company., Boston, Mass. — **Thomas E. Rounds**, Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488

# 24

The *Review* editors should salaam to our Class for conserving class notes space. The chill of the Dow Jones slide seems to have affected typewriters and pens.

**Lloyd Gensel** passed away in April, 1977, in Marietta, Ga. He was awarded his S.B. in general engineering after obtaining a B.S. from Whitman College in 1919. He entered the construction field, worked with the Supervising Architect of the U.S. Treasury Department and its successor, the Public Buildings Administration, rising to Division Engineer of Division 3 by 1949.

**Maurice T. Crowell** died October 7, 1977, in Milwaukee, Wisc. He was enrolled in electrical engineering. Circa 1949, he was resident manager of an employer's group, and in 1967, Vice President of Hiller Agency, Inc., in Milwaukee.

**Al Roig** was disturbed that my June notes indicated that a grandson was an Institute prospect. Al is really a great-grandfather, the little boy being 15 months old, the son of Al's granddaughter who lives in San Juan.

On the subject of progeny, your scribe adds a personal note: he recently attended in Albany, N.Y., the inauguration of son Gordon as President of the University of the State of New York and Commissioner of Education of New York State. He conferred honorary degrees on Nelson Rockefeller and two other former Governors of New York. Bob Sprague, '23, Life Member of the Corporation, represented M.I.T. at the convocation. My second son, Dwight, a career diplomat, is Counselor for Economic and Commercial Affairs at the American Embassy in Vienna, Austria.

The grapevine reports that **Phil Cohen** has retired and is living in Cambridge, apparently enjoying good health. . . . **Ray Lehrer** has announced retirement from his insurance business, but is busy doing nothing. He and Dot recently celebrated their 50th wedding anniversary. They will be with their daughter and family in Toronto for Christmas, in Florida in February and March, and in western Europe and on the North Cape in the summer.

All of you should have received Class President **Frank Shaw**'s October billet-doux, with his nostalgic reference to calculus and touching request for Alumni Fund support in 1978. This was meant only as a reminder of what you had planned, and by no means implies, "Give 'til it hurts!" We have already done that! — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, co-secretary, 8 Pilgrim Rd., Waban, Mass. 02168

# 25

A most interesting article entitled "See the Hidden Parts of Mexico by Piggyback" appeared in the *Boston Sunday Globe* on October 30, 1977. The author and traveler was **Willard Allphin** of our class. Willard has traveled 190,000 miles in his camper through the U.S., Canada, Mexico and Guatemala. For this trip he reported 64 people in 29 recreational vehicles in addition to cars which pulled trailers gathered at El Paso. The lead vehicle was driven by the "wagonmaster" and the rearguard vehicle by an experienced mechanic. They kept in touch with each other by radio. The group kept in formation until they had passed the several customs check points, with hardly a stop. All traveled at their own pace then onto the town of LaJunta where all were loaded onto four flat cars where the group lived for five days. Stops were made for meal times and at night, and for side trips accomplished in rather rickety buses through very rugged territory. Willard points out that the trip by train covered about 400 miles and they traveled at about 20 to 25 miles per hour. During the rail portion of the trip the travelers put their folding chairs on the deck and enjoyed views on both sides of the train. The rail portion of the trip ended at Los Mochis and then the caravan hit the road for 260 miles to Mazatlon on the Pacific. Willard went on by himself at this point, the caravan heading northward to Nogales, Ariz. By overnight ferry Willard crossed to Baja, Lower California, explored the southern portion of that peninsula and then headed north, some 1,100 miles to Tiajuana. Willard reported that the trip lived up to all superlatives that had been applied to it.

Why does it take us so long to learn of the interesting and responsible activities in which some of the classmates have been engaged? I recently learned some things about **George L. Washington** which takes us back to the early 1940s. At that time he was Dean of the School of Mechanical Industries at Tuskegee Institute. In late 1940 the War Department sought the cooperation of Tuskegee in the establishment of military pilot training in the Tuskegee area. George worked closely with the President of Tuskegee in the planning program w ich followed, particularly on bringing blacks to be trained as fighter pilots. Tuskegee was asked, also, to assist in the recruitment of the necessary ground support group. In 1976, George was asked to prepare a paper in connection with the Tuskegee Airmen's National Reunion which had as its theme "The Ground Support Team" and its slogan "They Kept 'Em Flying." He entitled his article, "To Insure They Never Fail for Lack of Top-Flight Ground Support," and this was featured in the souvenir booklet of the reunion. George mentioned that much has been heard about the black pilots of World War II but very little regarding the ground forces upon whom they relied. George did a fine job in emphasizing this fact. The letter noted that on September 1, 1977, George and Ruby entertained a few local friends in celebration of their 50th wedding anniversary. Hopefully, we may see George at the 1978 Technology Day.

**Tom Killian** writes that his appointment as Professor of Electrical Engineering at Portland State University has been renewed for the eighth time and that his son is about to receive his Ph.D. at Cornell. . . . Address changes are not common with classmates but **Paul Goble** has deserted the shores of Cape Cod and gone to live in Southern Pines, N.C. . . . The M.I.T. Club of Cape Cod recently had a bus trip back to the Cambridge campus, and **Ken Proctor** and his grandson were with us on that occasion. The September issue of *Forbes* magazine carried a page headed "Organizers," defining an organizer as one who takes scattered, inefficient means of production and welds them into an efficient whole. One feature of this page read as follows: "When Douglas Aircraft was floundering in the mid-sixties, **James S. McDonnell, Jr.** rescued it, combining it with the fabulously successful fighter-plane operation that he built up in World War II, now McDonnell Douglas."

With sorrow I must report the passing of two classmates. **Norman L. Mansfield** died on June 1977 at 12 Cambridge Rd., Glen Ridge, N.J.; and Colonel **Clifford C. Duell** died on September 25, 1977, at 611 Westmont Dr., Fayetteville, N.C. Colonel Duell was a native of Seneca Falls, N.Y., and came to M.I.T. to undertake graduate studies in mechanical engineering receiving both the master's degree and doctorate. He entered the army during World War I and was commissioned a second lieutenant in the army in the early 1920s. He landed in Normandy during World War II and served as Provost Marshall in Paris for the entire occupied Europe. He was a criminal war judge during the 1947 Dachau trials, served as military attache to Turkey in 1948 and retired in 1953 at Fort Bragg. The colonel and his wife, Martha, established the Shopper's Guide after his retirement and ran that business until 1974. He was author of several textbooks in use in automobile engineering. He was active in Masonry as a member of the John Huske Anderson Lodge, the York Rite and Scottish Rite Bodies and Sudan Temple. He is survived by his wife, two daughters and three sons. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass. 02650

# 26

This is an unexpected issue of Class Notes — not for you — for us. Somewhere in the pipeline our notes were lost at M.I.T. but we cannot let a 50-year record started by **Jim Killian** and continued by your present secretary, lapse. So a few items that were being saved for next month will fill the gap and they will be mostly Pigeon Cove oriented.

At the turn of the century the Navy and the politicians decided that the deep waters in front of our house would make an ideal harbor. In order to accomplish their goal it was necessary to build a breakwater about a mile and a quarter offshore and about a mile long. Those were busy days for the Rockport Granite quarries as the blocks weighing many tons were hauled by oxen to piers, loaded on barges and dropped into place. Things progressed and the breakwater began to shape up but the pork barrel rolled again and the Navy's interest became the Pacific. Work was stopped with only about 15 per cent of the breakwater completed above the water — the remaining 85 per cent is submerged, except at low tide, making a serious hazard to navigation even though well marked with buoys. Liberty Ships are piled up out there — the engine block of one still protrudes and a million dollar wood minesweeper grounded on the south end of the breakwater a dozen years ago and had to be burned. Recently while eating lunch Ruth and I noticed more than the usual amount of activity at the North End of the breakwater, so I rushed for the binoculars. A 35-foot sloop had cut inside the buoy at the North End of the breakwater at low tide and was hung up on a rock. "Shorty," our 6-ft. 3-in. 270-pound Harbormaster was on the job with the very fine Boston Whaler provided by one of our benevolent citizens. Its shallow draft and maneuverability made it possible to get the three passengers off before the Coast Guard arrived with their 40-footer from Gloucester. A half-hour later as the incoming tide lifted the sloop from the rock it rolled over and sank in 65 feet of water alongside the breakwater. A diver has been down and it appears hopeless to try salvaging the $50,000 cruising boat. The winds that day were a bitter 25 to 30 knots from the Northwest and there have been many storms since. So as we have often mentioned one can never tell what will happen next in our front yard.

We do have a bit of news that just came in via the Alumni Office. By the time you read these notes **Elton Staples** will have been married — that's all we know but it pleases us and we extend congratulations for the class. Also we had a telephone conversation last evening with **Bill Meehan** and learned that after his retirement from University of Massachusetts at Boston he was retained in a consulting capacity by the President's office. Apparently the new arrangement is less pressing because Bill and his wife were able to take a month's vacation in Russia in September.

Sorry we had to give you so much Pigeon Cove and so little class notes but we just could never miss an issue and we can still say Cheerio until next month. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

# 27

In October, **Dike Arnold** was awarded the 1977 Bronze Beaver by the Alumni Association, with this well-deserved tribute: "As past President of the Association, as a member of the Coproration, as Chairman of his 50th Reunion, as Director of his Fraternity, and in countless other ways over the past half century, Dike's leadership and support have been a source of strength to M.I.T." . . . For the ninth year in succession, **George Cunningham** has represented St. Andrew in da Vinci's "Last Supper" in the Pageant of the Masters at the Laguna Beach Festival of Art, held in 1977 from July 16 to August 29. Those of us who saw George at the reunion are wondering whether he was chosen for the part because of that handsome beard, or whether he grew the beard for the part. The 50th Reunion Book listed 61 members of the Class of 1927 who have been lost track of by the Class and the Alumni Association. We have since located a few, and I shall list some of the stillmissing in these notes from time to time. Does anyone in the class know the present whereabouts of these classmates: **George W. Acock, Harry V. Aivasian, Carroll C. Bailey, Eldred W. Bemis, Joseph L. Brady, Howard A. Chinn, Jesse I. Davidson, Jetha N. Diwan**.

Last month's notes contained a very brief mention of the death of **John A. Adams** in February, 1976. **Bob de Luccia** writes me that Jack Adams was the engineer who built the Saarinen Arch, the "Gateway to the West," which spans the Mississippi River at St. Louis and rises to a height of 630 feet. Bob writes: Jack Adams was an outstanding engineer. He received a B.A. from the University of Louisville in 1921 and then came to M.I.T. with our class. After graduation, he worked with the Army Engineers on construction of locks, dams, and other river structures. During World War II, as a colonel, he served as Deputy District Engineer, with responsibility for over $55 million of military procurement and construction. After the war, he became, successively, Chief Engineer for Robinsom Erection Company of St. Louis, Chief Engineer for O'dell-Rinig Company, and Vice President and Chief Engineer of MacDonald Construction Company of St. Louis. It was during his time with MacDonald that he directed the construction of the Saarinen Arch, as well as a Titan Missile site, a large steam-electric power plant, and many other projects. He was married in his junior year at M.I.T. to Marjorie Etna Murphy, and their one son, Jack Jr., is an engineer carrying on the family tradition.

I commented also last month that **Howard Ferguson**, who died in August, looked the picture of health at Wianno. I have since heard from his wife, Celia, that he had been well and strong virtually till the end. He died of a massive pulmonary embolism following prostate surgery. Cel has been left with one more house than she needs and is trying to decide whether to keep the home in Hendersonville, N.C., or the one in Apollo Beach, Fla.

Your secretary has again been fouled up by the lead time on these notes. Let me hope that you all had a Merry Christmas and will have a most Happy New Year. — **Joseph H. Melhado**, 24 Rodney Rd. Scarsdale, N.Y. 10583

# 28

Here it is — 1978! This is the year of our great 50th Class Reunion! Most of us who plan to be on campus June 6 to 11 have already sent in a response card or some other expression of interest. In a few weeks registration material will be mailed — but only to those then on the reunion list. If you expect to attend or hope to attend we must have your name before the next mailing. If you have not yet responded please do so at once.

*Brigadier General Benjamin Kelsey, '28, (left) was the first pilot to fly the Lockheed P-38 Lightning, one of the most famous combat aircraft during World War II. He celebrated the 40th anniversary of its flight with the designer, Clarence Johnson, and Tony LeVier, a Lockheed pilot who demonstrated its use for military pilots.*

Also there is still time to order your red blazer — but do it now! And, of course, **Jim Donovan** would be delighted to have your contribution to the 50-Year Class Gift.

On September 18, 1977, more than 300 citizens of Cambridge, Mass., gathered for dedication exercises at the new **Gustave M. Solomons** Transportation Career Center. The center, named in honor of our distinguished classmate, is a part of the city's high school system and trains students in automotive and engine repair work. Among the participating principals and guests were many Cambridge city dignitaries and U.S. Senator Edward W. Brooke. For many years Gus has been active in Cambridge civic programs including ten years service on the Cambridge School Committee. Also present were Gus' wife, Olivia, and their two sons, Gus, Jr. and Noel. Gus, Jr. graduated from M.I.T. in 1961 and is a Dean at California Institute. Noel, an M.D., received his degrees at Harvard and is now an assistant professor at M.I.T. To Olivia and Gus, our congratulations and admiration — you have every reason to be pleased and proud.

A news release of October 3, 1977, from Lockheed California Company, a Division of Lockheed Corporation, describes a "birthday" party attended by 1,600 persons marking the 40th anniversary of the design of the famous P-38 Lightning combat plane. One of the honored guests and a speaker at the event was our own retired Brig. Gen. **Benjamin Kelsey** who first flew the plane as the Army Air Force lieutenant in charge of the project. A photograph accompanying the release shows Ben with the plane's designer and Lockheed's demonstration pilot standing before the plane.

On October 20, **Gabe Disario** telephoned to report his presence in the Boston area. We were sorry to learn that his mother had died. In the course of discussion Gabe pointed out that his family is very much M.I.T. oriented. Daughter Caroline graduated in 1956, Department of Civil Engineering, and is now married to Russell Chihoski, '54, (metallurgy). Now granddaughter Helen Ann Chihoski is a Course X (chemical engineering) student. . . . During an autumn trip to Maine, Frannie and **Jim Donovan** visited with Marjorie and **Bill Bendz** who were about to leave their six months of summer residence in Boothbay Harbor for the comfort of their winter home in Los Altos, California. . . . Also from Jim we have news of Clara and **Arch Archibald** as they were headed out to view a solar eclipse aboard the cruise ship *T.S.S. Fairsea*. We can only hope that the weather was clear! . . . **George Chatfield**'s wife, Marie, had the misfortune to suffer a broken humerus bone. However, they did have a good vacation in Europe last summer and enjoyed a trip down the River Rhine to Holland.

We deeply regret to report that two more of our classmates have died. **Raymond Alexander Jack** died September 21, 1977. We talked by telephone with his wife, Lucille, and learned that Ray had been ill with emphysema for a number of years. In addition he was left inactive as the result of a ruptured disc. This was especially difficult since Ray had always led a physically active life. Ray's first job following graduation was with Firestone in Akron, Ohio. A year later he joined Standard Oil of Indiana and there made his career until retirement. Besides Lucille he leaves a son, David.

**James Goltra Willett** died October 11, 1977. A thoughtful note from Jim's wife, Elsie, provided this information and some of his life background. In his active years Jim was a Naval Aviator (Commander) and taught flying at Squantum, Mass. He became executive officer at Brunswick Air Force Base, Maine, and served also at the Air Base, Attu, Alaska. Following World War II he retired and became a fine enameler on silver and copper. He and Elsie were extensive travelers. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

# 29

The "Count Down" is on! The first meeting of the 50th Reunion Committee was held on November 17, 1977 at the M.I.T. Faculty Club, under the able leadership of the General Chariman, **Jim Fahey**. Those who were present were: **Bill Baumrucker** (President of our class) and wife Doris, **Wally Gale**, Ellie (Horwits) Sighera (Reunion Secretary), **Frank Mead** and wife Mary, **John Rich** and wife Olive and your Secretary. The Committee has chosen Chatham Bars Inn (on the Cape), the same place we had our 40th and 45th reunions. The date is: Arrive Monday, June 3, 1979 at Chatham Bars Inn and depart for usual Campus activities Thursday, June 6, right after noon luncheon. The Committee will come up with a full program, but it will be up to every member to do his "thing" to insure suc-

cess of the biggest event of our School activities. More to follow on this subject.

A brief note from **Bill Aldrich**, which states, "We are getting ready for our Mid-Western Mini-Class Reunion this Labor Day weekend at Billings, Montana." . . . **George J. Burke** is enjoying his retirement. Occasionally, he draws plans for his business, the Burke Corporation, which is a family oriented building, contracting, and construction business. He does some traveling and is still a bachelor after he lost his wife some years ago. George made a sizeable class gift at our 40th Reunion.

**Phil Sayles** writes, "We spent six weeks in Belgium and Great Britain this past summer. We visited our daughter and son-in-law who live near Brussels. Our daughter is P.R. manager for Blue Bell Europe (Wranger blue jeans), and her husband teaches in the International School of Brussels. After three weeks touring Belgium and West Germany, taking walks in the beautiful countryside, we took a North Sea Ferry to Hull, England. We toured England, Scotland, and Wales in the next three weeks, driving on the 'wrong' side of the street and using 'funny money' as well. We spent four days visiting old friends in Falmouth, Cornwall. Our hostess and my wife Mildred were Emerson College classmates. While waiting at Heathrow to catch our flight back to Boston, I ran into a well-known golfer, Ray Floyd, and his wife. I wished Ray good luck for his future tournaments, which (I like to think) might have helped him win the $50,000 1st prize at the Pleasant Valley Classic in Massachusetts a week later. He owes me a 'cut,' don't you think?"

**Charles Frank** is enjoying his retirement immensely. His second marriage has not only brought him lots of happienss, it has also given him an "instant" family along with it. He is boating with a married daughter, a married son, plus seven grandchildren. He and his new wife are active in civic affairs of Waltham, Mass., where they live and enjoy entertaining friends and relatives. . . . **Harold C. Pease**, has finally done it! He has sold his house in Ridgewood, N.J., where he has been living for the past 32 years and moved to St. Petersburg, Fla., to escape the rigors of the Northeastern winters. "It was a big move, but I felt that sooner or later, I would come to it, so why not now! The hardest thing was to get rid of items, some valuable, some sentimental, that had been accumulated for the past 32 years. I have been here now (August) for three weeks, and I am still trying to settle. Thanks for the Birthday Greetings. I always look forward to it." Harold was among the first graduating class from Course XVII (now defunct) along with **Howard Pankratz**, **Leonard Peskin**, **Robert Pride**, Your Secretary, etc.

**Edward B. Papenfus** writes from Vancouver, B.C., "We are still living in the same house we moved in 20 years ago. My wife presently is on a visit to South Africa where I plan to join her in 1978 to renew friendships and see relatives. I am still in good health and I do lots of exercise, as recommended for our age group." . . . **John Rich** writes, "1977 has thus far been our year for travel. At the end of July, it will have been 17 weeks away out of 28, which is more than 60 per cent. In January, my wife Olive and I were with the **Baumruckers** (**Bill** and Doris) in Dominica. In March we went to St. John, Baumruckers again, to Stuttgart, where Bill picked up his Mercedes-Benz and we toured Yugoslavia, Italy, and Switzerland. We are back to camp until August. What fun!" . . . **Amasa G. Smith** writes, "Thanks again for those Birthday Greetings that keep coming up regularly. We enjoy those messages that appear in our Class Notes in the *Review* which keep us informed about the rest of our classmates. We are looking forward to seeing you and other classmates at our forthcoming 50th Reunion. This starts my seventh year of retirement from Chicago Bridge and Iron Co. I manage to keep myself busy with United Appeal, Boy Scouts, Y.M.C.A., and being on Board of Directors and Trust Committees of Birmingham National Bank, which I have been doing for many years. I see **Larry Luey** on the golf course quite often. Best regards to all." Mace was present at our 40th Reunion with his wife Sara and their lovely daughter.

After living 18 years in New Hampshire (Lake Winnipesaukee area), **Bill Saunders** has moved to Naples, Fla. "I have now been retired for nine years. In Florida we play golf and do lots of fishing, using my boat which is docked in my back yard as we live on a canal, which is very convenient. We still come to New Hampshire during the summer, and spend one or two months in such familiar places as Laconia and White Mountains."

**Frank Mead** reports on the Mid-Western Mini-Reunion last Labor Day Weekend, as follows: "During the 45th Reunion, **Bill Aldrich**, who was present, remarked that it would be nice to have a mini-reunion at Billings, Mont., before our 50th. Mary Mead made a mental notation and from this remark, the reunion was eventaully planned and held as scheduled. **Wally Gale**, along with Frank and others, did the planning, with some help from the Alumni Office." Frank continues, "Wally, **Bill Baumrucker**, and I flew out of Logan in Boston on September 6. At Billings, we were joined by **Gus Stein**, **John McCaskey** and his wife. **Bill Aldrich**, our host, gave us a royal dinner that night at the City Club, of which he is a member. Bill's wife Maxine and son Gregg and his wife Thoro also accompanied the group. The following morning, the group left for Bill's beautiful mountain, lakefront cabin, about 80 miles west of Billings. Bill's daughter-in-law Thoro substituted as hostess as Maxine had a foot injury the day before our arrival and was unable to accompany the group. We naturally went fishing on the lake and in the stream leading out of it. Gus got the first prize by catching the biggest fish, a two and a half pound fresh water trout. We all enjoyed a superb dinner that night which was planned by Thoro. We played cribbage for a while and retired for the next day's activities. Next morning after a luscious breakfast of fresh trout, sausage, pancakes, etc. prepared by Thoro, Bill Baumrucker, Gregg, and I went fishing again. This time, Bill was the Champion fisherman for size and quantity. We retired to Billings and that evening Bill and Maxine had a Western Ranch style cook-out with all the trimmings which climaxed our stay at Billings. For this event, **Jim Fahey** and his wife Ruth (her friends call her Teddi) joined the group. Of course, we took time out to discuss our plans for the 50th Reunion, the Class Gift, etc. Friday morning, the group left for San Francisco for a dinner meeting arranged by **George Burgess**. Those attending, besides the Boston Group, were **Ted Alexieff** and wife Imogine, **Dick Piez** (who attended our 45th Reunion), Wade Stoiler and wife Dorothy, **John Howell, Jr.** and wife Kay, and Col. **Robert K. Haskell**. It was a fruitful meeting, exchanging ideas and discussing various topics associated with M.I.T. in general and our 50th Class Reunion in particular."

**Laurence R. Moses** has sent a brief note stating, "Kay and I are in excellent health and are enjoying life in the gentle climate of Sarasota, Fla. Our youngest daughter, Katherine Ann Mason, was married here in February, and is now Mrs. David A. Bianchi, living in Chapel Hill, N.C., where David plans to study towards his master's in Public Health. Our son, Laurence, was promoted to full Colonel, U.S. Infantry and is now Deputy Commander of the 56th F.A. Brigade in Germany. We hope to see him and his family in Germany this coming September." . . . **Walter H. Partridge** writes, "Dear Karnig: Thank you for my Birthday Card from the Class of 1929. We all appreciate the good work you are doing as Secretary. My main hobbies and activities are playing golf and serving as a Director of the Andover Historical Society. There are a number of other M.I.T. men who are on the Board with me, such as, **Jack Custer**, George Glennie, '24, and Arthur Muldoon, '48. I hope to join you again for next year's reunion events."

**Ira H. Abbott** sends his greetings to all his classmates from Moultenboro, N.Y., where he is living a quiet and leisurely life of retirement with wife Martha. The Abbotts have three children and six grandchildren (so far). — **Karnig S. Dinjian**, Secretary, 6000 N. Ocean Blvd., Apt. 14-E, Fort Lauderdale, Fla. 33308 (305) 942-0425

# 30

Once in a blue moon, more specifically once or twice a year, I receive an unsolicited letter from a classmate, and the arrival of such a letter always generates a warm feeling of gratitude toward the writer. The "volunteer" letter writer in this case is **Wallace Hope** who says — and there is nothing in my records to contradict him — that this is the first time since he graduated from M.I.T. that he has supplied information for the Class Notes.

Wallace was one of a rather select group that majored in electro-chemical engineering and initially had a bit of a problem finding a job where he could effectively use his special training. During the 1930s he bounced around a bit with a record of 11 jobs in nine years. Then in 1939 he settled into a more stable spot at the Port Huron, Mich., development laboratory of the American Enamel Magnet Wire Company, which had just merged with the Sterling Cable Corporation. Both companies were ultimately purchased by the Electric Auto-Lite Company during the period he was employed there.

In 1945 he moved to the Standard Varnish Works on Staten Island which ultimately became the Standard T Chemical Company, a wholly-owned subsidiary of Montgomery Ward. At Standard T Chemical Company he set up the physical testing quality control laboratory. He then developed the Wire Coatings Division for producing electrical conductors and was eventually designated its Chief Chemist with several assistants working under him. Many new products were developed there, "some receiving considerable acclaim," of which a few were used on apparatus transported to and left on the moon. Wallace worked for Standard T Chemical for 26 years during which time he commuted to and from his home in Ramsey, N.J., for what he estimates to be a total of 460,000 commuting miles.

In early 1970 he had a heart attack which persuaded him to let up a bit and in particular to eliminate the 90 miles per day of driving between Ramsey and Staten Island. Accordingly he shifted to Decorative Industries, Inc., a company in Sloatsburg, N.Y., only eight miles from his residence in Ramsey. At Decorative Industries, Inc., he became a vice president in charge of research and development, directing several lab technicians. He found the conditions of that employment ideal and anticipated that he would be there for many years, or at least as long as his health allowed. However, the three Hope children, all of whom are married with families, live in the middle West and Wallace and Nina decided to move farther west to be near them. Since two of the children live in Iowa, the Hopes moved to Boone, Iowa, in 1974, where they now live, and where Wallace says that he still does some consulting work for Decorative Industries. He and Nina are in reasonably good health and enjoy seeing their three children and their grandchildren fairly frequently.

According to Wallace there have been only a very few times over the last 47 years when the Class Notes has contained any reference to one of our electro-chemical classmates. His hope in writing me was that if the contents of his letter were used in the Class Notes, it might stimulate some other course XIV classmate to write. I hope that Wallace's gamble pays off. . . .

The other two communications this month are from two good friends, **Fred Garvin** and **Ed Giroux**, each of whom, apparently without collusion, commented on the fact that he had recently seen the other. Fred is still regularly employed as Deputy Commissioner of Public Works in Boston, currently substituting for the Commissioner during the latter's absence. His normal work is as Division Engineer in charge of engineering for the Public Works Department and Chief Engineer of the Public Improvement Commission. His work consists in supervising the output of the Engineering Division which is the service division for all other Public Works Departments, i.e., highway, sewer, water, lighting, etc. In addition to his mention of Ed Giroux, Fred mentions the fact that he recently bumped into **Ralph Murley** whom he

hadn't seen since graduation and who is now retired but has found a second career operating a jewelry store in Winthrop, Mass. Fred is scheduled to retire, probably next March, and has mixed feelings about it. He is looking forward to a less pressure-packed existence but is feeling nostalgic about being a small cog in the great urban renewal project that Boston has implemented in the last 15 to 20 years.

**Ed Giroux** retired some years ago from his job as a mathematics teacher and now shuttles back and forth between West Baldwin, Maine, in the summer and Pompano, Fla., in the winter. Both Ed and his wife Mildred are serious painters and own the Orchard Hill Art Gallery in West Baldwin. They enjoy the twice-a-year meetings of the M.I.T. Club of Portland, Maine, usually attended by 20 to 30 members. Ed says that he hears occasionally from **Vincent Thormin** in Canada. As previously indicated in the Notes, Vince has conformed to what appears to be a fairly common pattern among our retirees by moving to be near his children, in this case from Quebec to Calgary, Alberta. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

# 31

**Edward Goodman** writes: "Retired December, 1974 and loving it. My wife and I have logged almost 30,000 miles in this country and Canada, enjoying all the places we have wanted to see and which I never made on my extensive business travels. Spending most of our time in Williamstown, Mass., and would love to see any of the old gang." . . . Although I haven't been able to contact **Fred Elser** on my ham radio recently, a note from him says that he has finished his schoolwork for another master's degree and that he may go on for a Ph.D. Some of your ambitions amaze me. Incidentally, Fred is president of the O.O.T.C. (Old, Old Timers Club), which requires 50 years in ham radio.

All of us will be sorry to learn of the death of two of our classmates, **John L. Dodson** and **Jack R. Kalman**. Both passed away on July 2, but different years, namely 1970 and 1977 respectively. Hope that you all had a delightful Christmas and that I will be hearing from more of you in 1978. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; Assistant Secretaries: **Ben W. Steverman**, 260 Morrison Dr., Pittsburgh, Penn. 15216; and **John R. Swanton**, 27 George St., Newton, Mass. 02158

# 32

Barbara and **Nick Flatley** came in from Washington, D.C. to attend the Alumni Officers Association meeting. **George Kerisher**, **Don Whiston** and I with our respective spouses joined them in several activities. Nick has many thoughts for our class and in due time will share them with us.

We were pleased to have Marjorie and **William Pearce** with us also. William is still active with the Pearce Engineering and Sales Co. They are manufacturing representatives of the Graphite Metallizing Corp. and their sales cover six states. William and Marjorie play golf and bowl. They have three married daughters and eight grandchildren. All this keeps them quite busy and they hope to spend Feburary in Florida.

I attended my 50th High School Class Reunion in Salem, Mass. I was very pleasantly surprised to run into **Clarence G. Root** and his wife Emily. He was full of vim and vigor. He is working full time with Stone and Webster and perhaps will consider retiring at 70. He and Emily enjoy gardening, especially raising flowers. I promised to come to Groveland, Mass. and see some of their creations.

**John Brown** enjoys his semi-retirement from Badger, Inc. in Cambridge. This summer he toured Rumania for three weeks with side trips to Russia and Turkey. Skating is his favorite hobby. This year when the Skating Club of Boston puts on the Ice Show, CHIPS, you can again see John doing his part.

**Robert B. Semple** served on the Research and Policy Committee of the Non-Partisan Committee for Economic Development. This 60 member panel of business and educational leaders offered six fundamental principles to guide President Carter and Congress in forging a national energy strategy. Their report was issued on June 23, 1977.

**Phil Benjamin** and his wife Helen were delighted to meet **Jim Harper** at the 45th Reunion. They reminisced plenty about the comic magazine *VOO-DOO* of which, in 1932, Jim was general manager and the then Helen Powers was secretary.

It is with sadness that I must report the passing of the following members of our class: **H. Archer Clark, Jr.** of West Hartford, Conn.; Professor **Theodore A. Chadwick** of Bolinas, Calif.; **Theodore J. Jones** of No. Augusta, S.C.; and **William F. Spreen, Jr.,** Atlanta, Ga.

I shall write and extend our class sympathy to their families and ask for more obituary information. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

# 33

A postcard from Dot and **Bill Huston** reports that they spent a week tied up at the Athens port, then were to take off for Istanbul and the rest of the Aegean. I wish I could show you the snow atop the range of mountains close by their ship. Seems they encountered antiques 3,000 years old; that's even older than I feel these mornings.

**Cal Mohr** has a couple of short ones: **Fran Vaughan** was seen in or near Tennants Harbor, Me. Cal is proud that so many Course X men were selected for the 45th Committee. **Meyer Shnitzler** told Cal that one **George Hollingsworth** passed away 12 years ago. Meyer and his wife visited us in Florida a few years ago.

**Henry Kiley** assures us of the good health of Betty and himself. Betty studied at M.I.T. as a graduate student, but her B.A. is from Emmanuel College of Boston. . . . **Ellis Littmann** and I planned to stay at the same hotel for the Alumni Officers Conference but I had to renig since my doctor advised me to cut out some activities following an operation. Westy attended, as well as **Jim Turner**, Ellis, and **Bill Barbour** and his wife, which is better than the average of other classes. *Forbes Magazine*'s 60th anniversary issue cited **Pierre S. DuPont III**, for his innovations in centralized financial controls, and the executive committee system at DuPont.

*Arthur C. Ruge, '33*

**Arthur C. Ruge**, Sc.D. 33, has been honored with the Albert E. Sperry award. This award carries with it a certificate, medal, and a $1,000 honorarium for Technical, and Educational contributions to the field of instrumentation. Dr. Ruge was cited for his contributions in the field of strain, load, temperature, and pressure measurements. His undergraduate degree is from Carnegie Tech.

We have had more than our share of losses through death. **William H. Siebrecht III** wrote me about himself just before he died on October 3, 1977. It seems that he, and several other M.I.T. men from the Radiation Lab, formed a General Radiation Lab, in Pleasantville, N.Y. Bill stayed with these folks until 1950, when he joined the Norden Labs, an off-shoot of the old Norden Labs, in White Plains. Norden was originally the old Bomb Sight Company. He is survived by two daughters, one living in Medford, Mass., and the other, Margaret Steffensen lives in Urbana, Ill.

Another who has passed to his reward is **Peter A. Sorrentino** of Marblehead, Mass., on March 30, 1977.

**William W. Brothwell**'s death was reported by his Executor; he leaves no next-of-kin that I know. I knew Bill very well indeed at one time, and knew that he was a bachelor, with the support of an invalid mother. Gee, this must be 12 to 14 years ago. Bill was a little fella, but a hustling salesman, but for whom I cannot recall.

**Gene Cary** of Aurora, Colo., passed on October 11, 1977, and his wife Doris wrote me almost immediately. I wish to quote from Doris' letter. "Dear Warren: Gene passed away on October 11. He has been an invalid for 25 years, with multiple sclerosis. He did enjoy your Class Notes, in the *Technology Review*. He passed away in his sleep, ready to go." This lovely letter reminds me of one I received from **Duke Selig**'s daughter earlier.

With all pleasant thoughts, we wish y'all a very happy new year. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

# 35

**Robert W. Lindsay,** retired Professor Emeritus at Pennsylvania State University was awarded the 1977 A.S.M. Albert Easton White Distinguished Teacher Award at the Society of Metals recent Annual Meeting in Chicago. Dr. Lindsay received his master's degree in Course III with us in 1935.

The following were listed among the donors for Huntington Hall, formerly room 10-250: **Chester E. Bond**, **Arthur R. Anderson**, **George A. Callister**, **George C. Dunlap**, **Theodore A. Earl**, **G. Peter Grant**, **Richard L. Hughes**, **Hugh L. McMath**, **Charles F. Partridge**, **Warren E. Sundstrom**, **Edward H. Taubman**, **Frederick F. Tone**, **Vinton K. Ulrich**.

I had dinner the other night with our West Coast Vice President, **Charlie Piper**. He was making one of his field trips to GTE for TRW and we spent a fine evening together going over Theta-J Relays in detail. He shall be moving into larger quarters soon and the future looks better than ever. . . . **Hal Everett** is doing industrial marketing consulting and is a distributor for some electronic products. He telephoned on his way back from visiting his daughter in Laconia, N.H., and older son at New Hampton in late summer.

**Bernie Nelson** constantly reminds me to tell you the '35 mini-reunion will be held as usual on Friday evening on Technology Day: cocktails and dinner with **Bernie Whitman** to entertain us. More next month.

If these notes seem short, it's because I have no news to pass along to you, except that I have been so busy with my two-year-old company (Theta-J Relays) that I have little time for anything else. It will not always be this way, I am sure. I look forward to a chance to call you up and talk, or how about a letter? — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

# 36

Ten classmates assembled in West Hartland, Conn., on October 29, and another 47 responded to your Secretary's invitation, many of them with news. Those who joined my daughter, Martha, and me for luncheon and/or dinner were Mary and **Fred Assmann**, from Pennington, N.J.; Virginia and **Dick Denton** from Marlton, N.J.; Vivienne and **Eli Grossman** from Farmington, Conn., and Marion and **Tony Hittl** and Marian and **Jim Patterson** with daughter, Marcia, from Pleasantville, N.Y. Down from their new homes in northern New Hampshire were Rilla and **Walt Macadam** who have settled in Hanover, and Peg and **Fletch Thornton** who now live in New London. Lillian and **Larry Peterson** drove over from Schenectady and **Mitch Sieminski** stopped by on his way from Boston back to Bedminster, N.J. Virginia and **Augie Mackro** came up from Monroe,

Conn. It will take me several issues to share all of the news with you. It took those who attended nearly 45 minute each to read it all! I promise to share it fully.

For a start: **Augie Mackro** retired from Sikorsky Aircraft a year ago and is now running his own business, Macro Systems, Inc. in Shelton, Conn. He and Virginia have traveled to Hawaii and then to California when their son, Jay, (M.I.T., '71, Course II) graduated from the Stanford Graduate School of Business Administration. . . . **Bob Sherman** reports from Warwick, R.I., that he is presently Chairman, Science and Math, at Pristol Community College in Fall River, Mass., and is also deeply into geneology. . . . **Marshall Holcombe** and Vivian live mostly in Naples, Fla., but have a beach house at Hilton Head Island, S.C. He says he attends several board meetings regularly back in Wilmington, Del., but doesn't pretend to be doing much work — *except* volunteer hospital work, local bank board, United Fund board, etc. . . . **Stan Smith** elected to take early retirement from Bendix in South Bend after 37 years and has since been very busy with the United Way, County evaluation and allocation, and the Board of Trustees of the Indiana Vocational and Technical College. He and Rowena have done some traveling and get in a fair amount of sailing on Lake Michigan.

**John Bete** lives in Marion, Mass., where he has a boat yard and a 35-foot-ketch, but he commutes regularly to Greenfield, Mass., to check on the welfare of Bete Fog Nozzle, Inc. . . . **Norman Cocke** has settled in "thoroughly" in Myrtle Beach, S.C. . . . Jo and **Larry Sharpe** are dividing their time between Glencliff, N.H., and Florida, and went south on October 15. . . . **F.S. (Pete) Peterson** went south, too, but to Port Arthur, Tex., on Texaco business, and returned back home to Beacon, N.Y. . . . **Stan Levitt** responded from Midland, Tex., and wants to know how a bunch of "paunchy, arthritis-ridden senior citizens" are going to be able to hike in the woods. Well, if the truth be known, we don't *all* of us hike. Some of us sit and some of us just take a stroll.

**Roman Ortynski** has moved from Bel Air, Md., to Peachtree City, Ga. (30269). The new home is at 100 Pinegate Rd., and by the time you read this they should have finished unpacking and hung out their latch string. . . . **Henry Mabie** is doing educational computer programming at Rutgers University.

Several classmates sent me, from *Business Week* of August 15, an article on **George Trimble** entitled "The Master Tinkerer at Bunker Ramoe." George has been President and Chief Executive since 1970 and is credited with that company's rebound into the black. I wonder if George still has time for surf fishing.

The program for the dedication of the Alumni Center and the presentation of the new Huntington Hall (10-250) which took place in October lists as donors **Bunkie Knudsen**, **Gerald Blackburn**, **Norm Copeland**, **Ben Dayton**, **John Easton**, **Stanley Freeman**, **Ed Halfmann**, **Roger Huston**, **Irving Kelsey**, **Morris Lepes**, **Roger Krey**, **Phil Ober**, and **Leonard Stoloff**. I have not done any statistical analysis of the entire report, but that represents a fine showing for our class. Thanks to each and every one of you. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

# 38

The big news contines to be '38 in '78. **Dave Wadleigh**, Chairman of the Reunion Committee, is making some great plans. Be sure you reserve June 8 to 11 for M.I.T. Dave says that the reunion will be held on campus in Burton House, which has just been renovated. From preliminary responses, it appears this will be the biggest reunion the Class has ever had.

**Ed Hadley** has been putting together the reunion book and he called me a few days ago to say that the questionnaires are rolling in. He thanks you all for your time and effort in making the reunion book a success; he looks forward to a complete set of returns by the end of February. To those classmates who have sent in sheets without photographs, Ed says he will accept informal or family pictures; to those who did not notice the request for a 150-word autobiography, he would like that, too.

**Haskell Gordon**, 40th Year Gift Chairman, reports that the fund is well on its way and is meeting the goals that he is striving for. As part of the reunion gift, we adopted a project to raise funds for the central gallery in the new alumni center at M.I.T. This gallery is named in honor of Mrs. Compton. By now, the reception and dedication have been held (December 2 in Boston); all of you were invited, and the event is now part of the history of the Class.

A few random notes: **Don Severance** reported that at the San Francisco Airport he ran across **Jack Summerfield**. Jack, who now lives in Santa Monica, was returning from a consulting assignment with one of the smaller airlines in the Bay area. . . . **Sam Steere**, who has been retired from the Air Force for 3,000 years, is teaching part-time at a community college. His hobby is ham radio. Any of you radio buffs can reach him using his call sign N7SS.

**Bill Whitmore** received an extensive write up in a house publication of the Ocean Systems Division of Lockheed, where he is chief scientist. Bill is on the M.I.T. Corporation Visiting Committee for mathematics. Ed Hadley will summarize the write-up in the Reunion Yearbook.

I received a newspaper clipping that **Arch Thompson** died last August. Arch was a retired U.S. Army Major and served with the engineers in Fort Belvoir and the Philippines. On retirement he became an administrative executive with Liberty Mutual Insurance Co. — **A. L. Bruneau, Jr.**, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y.

# 39

**Aaron White** is due to receive special congratulations this month because he has traded salaried status for a new career as President and Technical Director of Opti-Met Laboratories, Inc. headquartered in Newton, Mass. Whitey offers microstructural analysis of metals, "cross-sectioning" of printed circuit boards, opaque ceramic and resinographic sample preparation, failure analysis investigations, and in-plant consultations on metallurgical problems. At our coming reunion Whitey ought to have some good yarns to tell about how an entrepreneur packs 26 hours of work into 24-hour days.

**Evan Pancake** continues his research work for Texaco near Bellaire, Texas, and enjoys making trips in his large motor home. We were sorry to miss him during his September trip to La Jolla. . . . **Bill DeLia** was elected to the Board of Directors of Credle Equipment Company which serves central and northern New York with heavy equipment.

**Wiley Corl** accepted assignment as Sales Manager of the Power Products Division of Catalytic, Inc. . . . **Sid Silber** and Jean just returned from a two-week trip to England to spend a few weeks in their beautiful home near Baltimore, before bringing their family to spend the Christmas holidays in the San Diego area. Sid has interests in developing real estate, and I would suspect he is about to discover a huge difference between real estate appreciation rates in England and those in the Pacific Southwest.

Bernice and **Charlie Friedman** recently flew cross-country from Freeport, Long Island, to spend a few days in La Jolla, and it was pleasant for Hilda and me to share a few hours with them. Thirty-two years ago Charlie and Bernice lived in an apartment near Arlington, Va. and they hosted me there for a couple of overnights. I must say that 32 years is a long time to wait to return their hospitality. Charlie reports **George Dadakis** is active in real estate and other investments, and **Joe Mazur** continues to operate in the furniture business in the metropolitan area. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, Calif. 92037

# 40

*Hail, Beavers:* **Norman R. Klivans** and **Alfred C. Wu** deservedly were awarded Bronze Beavers this year at the Alumni Officers Conference. Watching with pride were their classmates: **Bruce Duffett**, **John Danforth**, **Oliver Fulton**, **Samuel Goldblith**, **John Joseph**, **James Rumsey**, **Louis Russoniello** and **Philip Stoddard**. (Thanks to Bruce for his note giving the news.) Norman is active in the Cleveland area, and Al Wu in the New York City area.

*Travel Abroad:* **Amos E. Joel, Jr.**, of Bell Lab fame, and past president of the Communications Society of the Institute of Electrical and Electronic Engineers, was a member of an I.E.E.E. delegation to the mainland Chinese cities of Nanking, Shanghai, Soochow and Canton. The travelers and their wives were guests of the Chinese Electronics Society from September 27 to October 15. Technical exchanges between I.E.E.E. and the Chinese were discussed as well as the broader technological issues in the Peoples' Republic of China.

*In Boston:* **I. M. Pei**'s model for major improvements to the Boston Museum of Fine Arts was the centerpiece of a program announcing a fund-raising campaign for the museum. Pei's addition will house 11,000 square feet for exhibitions, an auditorium and restaurant.

*Great Businessmen a la* Forbes: The business weekly (September 15 issue) includes **Henry E. Singleton**, Teledyne founder, among 60 of the "greatest — the pioneers, organizers, men of vision. . . ," tycoons of recent history.

*So Soon?* June, 1980, will be the time for our 40th Class Reunion. A generation of years since graduation, time in which so many of us have met and married our childrens' mother, raised the brood, made a career, and on occasion, given more than a brief thought to how short the time from May to September. The column invities feelings and opinions about the 40th Reunion.

*In the Thereafter:* **Ted Gundlach** writes, "Retired April 1 from Elox Division of Colt Industries. Have been mostly visiting four grandchildren since then plus working as a consultant on manufacturing and mechanical engineering problems." Let us hear more. — **Frank A. Yett**, Secretary, 1405 Ptarmigan Dr., Walnut Creek, Calif. 94595

# 41

*National Academy Of Engineering Meeting*: I had the opportunity to attend the National Academy of Engineering meeting on "Innovators and Entrepreneurs — An Endangered Species?" which was run by its President and our classmate **Courtland Perkins**. On the panel were Dr. **Ralph Landau**, Dick Morse, '49, and Ken Olsen, '50, all M.I.T. The purpose of the meeting was "to address various environmental, financial, legislative, and psychological factors in today's society that adversely affect the process of moving innovative technology from its conception to its introduction in the marketplace. The presentations will be based on the personal entrepreneurial and management experiences of the speakers in the chemical, high-vacuum, and computer industries, and will identify problem areas as well as remedial approaches necessary to revitalize the art of innovation and entrepreneurship in both new enterprises and large corporations." It did!

*Miscellaneous Intelligence*: I have been told **Joe Gavin** is interested in energy devices — especially applications for the windmill.

*A New Year*: It is only November but I must wish you a Happy and Prosperous New Year. Please resolve to write me in this New Year. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn. 15230

# 42

Darn good thing that I didn't squander all the news that I scrounged at the Alumni Officers Conference on the December issue. If I'd done

that, this page would be a blank because news and letters from you all have reached an all-time low of none, zilch and nothing! So I'll put my usual plea up front instead of at the end of the Class Notes. Please Write!

Met **Mort Goulder** at the A.O.C. He was with Sanders Associates for many years and recently finished a stint as Deputy Assistant Secretary of Defense for Intelligence and Warning. Mort's card now reads *Private Consultant* and he is working from his address which is 97 Ridge Rd., Hollis, N.H. 03049. If you need some consulting privately, or some privates consulted, phone him at (603) 465-2298. . . . Also saw **John Stanitz** at the A.O.C. He has been doing consulting since 1966 in Cleveland. The Stanitz's probably hold the class record for children, with eight on their roster. John's bookish hobby is rare first editions and he's apparently become so successful at it that the Institute has put him on the Visiting Committee for Libraries.

Ran mini-biogs of our President, Executive Vice President and Treasurer last month. Here are three of our five Regional Vice Presidents: get in touch with them and promote some '42 activity in your areas. At least then, a few of you might write me a joint letter, and split the postage.

First, on the West Coast we have **J.J. Quinn**. His wife is Betty and they have two daughters; Kathleen, 22, and Shauna, 21. J.J. is Captain of the Golden West Airlines for a living and races high-speed sail boats off the California coast for fun. He was a test pilot in the U.S.A.F. and flew the P-38, P-47, P-51 and P-61. He then joined Northrup and made the first flight of the YF-89 in 1950.

The Midwestern Regional Vice President is **F. Richard** (otherwise known as Dick) **Meyer III** of River Forest, Ill.; wife is Geraldine and they have three children; Sue, 31, Charles, 29, and John, 25. Dick has been a consultant and broker in mergers and acquisitions for the past 20 years. Dick is Mr. M.I.T. in Chicago-land. He has served as an educational councilor, an active member and officer of the M.I.T. Club of Chicago, and as a Fund solicitor whenever needed. He was elected a member of the M.I.T. Corporation at its June, 1977, meeting.

**Harvey Kram** holds forth as the New York Regional Vice President, which I guess is from southern Connecticut out to western Pennsylvania, and then south to Washington, D.C. (That is assuming that Virginia is the north end of the south.) Harvey and Eleanor live on Long Island with two children; Leonard, 22, and Kathy, 27. Harvey is Vice President of Leviton Manufacturing Co. in Brooklyn. Guess we've all installed their plugs, receptacles and sundry other electrical fittings in our homes. Harvey worked at M.I.T.'s Radiation Lab, then spent a few years in the automotive industry as a factory manager and has been with Leviton ever since. That is except for a year, in 1959, when he lost his senses and worked for the famed Charles Revson at Revlon.

Merry Christmas and a Happy New Year to All — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

# 43

**Mort Schultz** was named President of ACLI Metal and Ore Company last September, a division of ACLI International, Inc., one of the world's largest commodities trading companies. Active in metals trading for many years, he was formerly a first vice president of Bache Halsey Stuart Shields, and is a member of the Commodity Exchange, Inc., the Copper Club, and the American Institute of Mining, Metallurgical and Petroleum Engineers. He and Irene reside in Rockville Center, N.Y. . . . Last October **Chris Matthew** was awarded the Alumni Association's 1977 Bronze Beaver, in recognition of a quarter century of distinguished service to M.I.T. in both San Francisco and Cambridge.

I regret to report that the youngest member of our class, **Tom Derby, Jr.**, passed away last September. He entered with us in 1939 on his 16th birthday. He was a pioneer in the fields of frozen foods and the wrapping and marketing of self-service meats, and was International Sales Manager of FMC Corporation of Philadelphia. He was justly proud of the three generations of Tech men in the family: his father was Class of 1921, and his son, Tom Derby III, is a 1970 graduate. We sent our condolences to his wife, Kitty, of Bryn Mawr, Penn. . . . We also report the death of **Lewis Rupp**, a prominent consultant who was the director of offshore gas and oil research for Mobil Research and Development Corporation. A 1937 Annapolis graduate, he received his master's degree in naval construction and engineering with our class, and was a retired U.S. Navy Captain. . . . Professor **John H. Moss**, who received his master's in geology with us, passed away last July in Lancaster, Penn.

Class President **Ken Warden**'s letter of last November advised us, among other things, of plans for a fabulous 35th Reunion, including a clambake on an offshore island and a cruise of Boston harbor. I do not know whether **Oivind Lorentzen**'s *Kungsholm* will be the chartered vessel for this affair, because our harbor soundings survey is incomplete. Please remember to send in your return postcard indicating your interest. — **Dick Feingold**, Secretary, 779 Prospect Ave., West Hartford, Conn. 06105

# 44

An October letter from **Norm Sebell** reports: "It's obvious that ESP exists between the **Teixeiras** and the Sebells. Ruth and I spent a week in Bermuda in May and while there we visited the Deepdene and reminisced about the grand time we had there on our 30th. Never one to pass up the possibilities of a good time, Ruth suggested, 'How about having an interim 34th reunion here again? So many classmates have written you about it already.' Sounded like a great idea, so we rounded up the manager, had drinks (gratis, of course) on the patio, and worked out the possibilities. Needless to say, air fares and hotels are higher now but we think we managed a reasonable deal. Now we are all excited about the idea; . . . Ruth and I agreed to chair both a possible 34th and a definite 35th. . . . Alumni Day is now on Friday instead of Monday. Although it is not mandatory, this makes it extremely difficult to plan any five-year reunion off-campus and, consequently, all classes have held them at M.I.T. Since the 35th will probably be held on campus, the idea of a 34th in Bermuda may be appealing to many who cannot or do not desire to come to Cambridge. At this point, it is only an idea. Since we do not have funds for a general mailing to the entire class, etc., I am simply asking that any of you who are interested write to me at the address below and let me know that you would like further information. Dates are optional but I suggest mid-to-late May or early June. If I have any response at all, we're on. We don't look for 100 people but if we could entice 10 to 15 couples, I'm sure we can have a ball. I will communicate only with those who write me so it's up to you. Even if you're not certain but willing to entertain the prospect, please write and keep up to date on our plans: Norman Sebell, 100 Burlington St., Lexington, Mass. 02173."

**Art Peterson**, our classmate in Tonawanda, N.Y., spent his Labor Day writing us a letter: "The letter you published in the summer *Review* accomplished its purpose: I'm writing. I looked up **Robert Clarke** and there he was, right in my yearbook. I don't think our paths crossed, but then the Class of '44 really had only two years of what most people call 'college life.' Naturally I remember **Melissa Wood** and my only regret is that I didn't establish my E.R.A., Title VII, and Title IX credentials right then and there by pledging the first woman to Lambda Chi instead of only rushing her. I guess there is a limit to how far one can be ahead of his time!"

Art's latest career change was more radical than most: "In 1971 I left an industrial management position (with a steel company) to devote full time to public education, which I thought then and still think suits me better than mining iron ore. . . . I have an unusual and perhaps unique position in the suburban Buffalo school districts. While I was hired to take care of negotiations and general labor relations, I find that my financial experience is probably what gives me whatever unexpected value I have to the institution. Just as I was an instant expert when New York passed its public employment relations act, I find that I am a budgetary and cost control wizard when compared with the education majors who have been running public education finance. Most school business managers have all they can do to master double-entry bookkeeping. They have just discovered the computer and are now at the stage where anything printed on green and white I.B.M. paper is assumed to be the word of God.

"All of the above is surprisingly related to M.I.T. and what I learned there. My record as a scientist was run-of-the-mill, although in my early years as a member of the steel company's research department, I did contribute to the taconite development in the Minnesota iron-ore industry. Nevertheless, while I was not and am not a great physical scientist, I believe with a passion that the laws governing human social behavior are as immutable and basic as those governing the physical world. We just don't know much of anything about economics or sociology in the sense that we understand thermodynamics or motion. If I am right about this, people as individuals or groups behave in some logical and predictable manner, just as atoms and molecules do. Unfortunately, sociology and other social sciences lack the discipline or the historical basis (or the simplicity) to have earned the prestige of physics or mathematics. It's much like teaching not having the professional status of the law or medicine. Whether this is fair or not, it is true, largely because we live in a world where status is the result of people's perception and not a matter of objective truth. The stock market is probably the best example of that fact.

"So now that I am working with teachers' unions and political reactions to school budgets instead of with the extractions of titanium dioxide from specular hematite, I'm still using the same techniques that I learned at M.I.T. In the laboratory, you do not achieve a result because you want to achieve it; you get the result that must come about from the temperature, pressure, and whatever else affected the compounds you mixed. So you instinctively acquire a kind of detachment toward your work which is invaluable when the problem happens to be one involving people. When I work on resolving a grievance, I care very little whether the teacher is someone I admire or someone I despise. I normally have very little trouble looking at the problem in a dispassionate way. No one is ever completely objective about anything, of course — including laboratory experiments — but someone educated as a scientist is better able than most to take an unemotional perspective on a complex problem.

"When I go on like this, I sound hard and almost cynical, even to myself; (but) I pride myself on being humane. I don't believe there should be, or is, any conflict between the scientific approach to a social problem and the need to handle the solution compassionately.

"This leads to another conclusion in my attempt to relate a scientific education to a career in personnel management. The objective, dispassionate, systematic approach to touchy social problems is almost always more humane and equitable in the long run than is an emotional one. I'm not much for existentialism or situational ethics.

"So that brings you up to date from the Niagara frontier. Keep your sense of humor. It's the only way to stay sane in this absurd world." Thank you, Pete, for taking the time to share your experience and thoughts with us. — **Melissa** and **Newton Teixeira**, Co-secretaries, 92 Webster Park, West Newton, Mass. 02165

# 47

Just too late for the last issue came news of **Vince McKusick**'s confirmation as Chief Justice of the Maine Supreme Court. It is a particular tribute to Vince that he has been selected to serve in this position, since everyone involved knew he would

consider it necessary to disqualify himself from the cases concerning the utility matters in which he has had interest. He was attorney for New England Telephone in an appeal of rate cut decisions, which must come before that court, and his law firm, Pierce, Atwood, Scribner, Allen and McKusick, is also involved in a number of appeals stemming from Public Utilities Commission action last year on Central Maine Power Co. rates. Vince is the co-author of *Maine Civil Practice*, the standard authority on that subject, and is a Chairman of the Board of Editors of the *American Bar Association Journal*. Maine's Governor Longley speaks of him as "one of the outstanding lawyers in America today."

**Adelaide Toombs Sundin**, now living in Delaware, was in the Ceramics Department, studying the making of porcelain as it could be applied artistically. She is now doing portraits in porcelain, and sent a card announcing her exhibit *Mothers and Children*, at the Boston Athenaeum during the month of November. She writes, "My husband is a mechanical engineer from Sweden and we have two sons, one a junior at Williams, and the older son a graduate of Yale and now a graduate student in biology at M.I.T. working towards his Ph.D."

**Robert Anderson**, who went to Wooster by way of Worcester, is President and Treasurer of Whitaker-Myers Insurance Agency in Wooster. He has been a member of the City Council for ten years, president for eight. Priscilla teaches third grade. Their four children range in age from 22 to 29, and they have three grandchildren. Both Bob and Priscilla enjoy touring restored America. They write that the 30th was "our first reunion, but not our last."

Those of you who accepted Assistant Secretary of Commerce **Jordan Baruch**'s invitation to stop by, and tried to visit him between September 27 and October 15, discovered that he was not at home. He was one of ten delegates of the Institute of Electrical and Electronics Engineers visiting mainland China as guests of the Chinese Electronics Society, touring Peking, Nanking, Shanghai, Soochow, and Canton. Objectives were to assess communications, to work toward technical exchanges between the I.E.E.E. and professional societies in Japan, and to examine broader technological issues in China, starting with innovation and diffusion of new technology. Jordan had a good look at China's technological progression. After ten years of relatively slow development, the last year and a half has seen significant strides in technology and in its application to industrial development. The I.E.E.E. release stated that the delegates would visit "the Peoples' Republic of China as well as their wives." This meant what I hoped it meant: Rhoda went too.

**Parker Symmes**, a partner of Symmes, Maini, and McKee in Cambridge, had been involved in building energy conservation consulting work for many years before the current general interest. In 1955 he left Cabot, Cabot, and Forbes, where he was chief mechanical engineer, to form a partnership with Vincent Vappi, '48, which eventually became S.M.M., with Bill Maini, '51, as partner. Parker and Midge have five children, ages 16 to 20. They enjoy skiing and hiking, and Parker plays tennis every Thursday night, year-round.

Message for all: Any messages you send to the Notes included on Alumni Fund envelopes should include a repetition of your address. The flap with the address is cut off and disappears into moneyland.

**Ginny Ferguson Ean** regretted missing our 30th in June. Her daughter's wedding was the same weekend. . . . **Claude Brenner** does it again! I figured he would be so busy with his work this month that he would scarcely have time to do anything newsworthy. However, it seems that he could not bear the thought of sitting in his chair in 10-250 between **Dick Knight** and **Hari Aldrich** at future A.O.C. affairs, with Mary sitting elsewhere with who knows what scurvy M.I.T. alumnus type. In typical incisive Brenner style, he solved his problem with HIS and HER chairs. Dick graciously moved over a bit and the Brenners are reunited in *The Seventh Row*. (Logistical note: they had to exchange chair backs; the brass plates are not removable.)

I saw some of the writing tablets which were ready to go out to chair donors. They are the original 1916 writing arms, finished smoothly, but with the graffitti still alive. Very impressive with brass plates identical to those on the chairs. By the way, if your company matches donations, you need only make up the difference to "buy" Your Very Own Chair. And you would finance it over the several years. Much more visible in 10-250 will be the names of those who prefer not to get into furniture, but have made donations with no chairs attached. We won't get a Class of '47 Plaque, but names will be enshrined alphabetically somewhere there.

**Bill McCurdy** is an account executive with Merrill, Lynch, Pierce, F, etc. His early experience with wind-tunnel testing and aircraft is now being put to use in power- and sail-boating. Virginia is his first (and only) mate. She works as a volunteer for the Connecticut Society for the Prevention of Blindness. Bill is also a Past Commander of the New Haven Power Squadron.

**Ginny Grammer**: The back of my house is now done and my conversation will use words like scaffolding, clapboards, and caulking. "Doing it myself" was an interesting experience, but not one to be repeated very soon. This is sad in one way: I have a much better idea now of how to do it. I had help along the way, especially with such things as gutters, and last summer son Charles really got things started well by replacing two rotted sills and some sheathing (over a hundred square feet), and clapboarding one face of the building. (I really *do* talk about myself when you don't write.)

Here's a cheap way (cheap for you) to get information to me: call me collect after midnight. I had hung up after a recent call before I realized I had accepted a collect call from Brazil without a name being mentioned. Fortunately, out of all those people in Brazil, it was my daughter Margaret, who has been in Brasilia since June. (Transferring charges to the U.S. end saves about 40 per cent in Brazilian taxes. Saves Margaret even more. . .)

Classmates, please write, wherever you are! Love — **Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, Mass. 02129

# 48

**Julian Taub** has been appointed Vice President and Treasurer of Bloomingdale's in New York City. Julian joined the large retail store last year as Special Assistant to Lawrence Lachman, Chairman of the Board. Julian began his career in retailing on the Abraham and Straus Training Squad in 1949. Before he left A.&S. in 1971 Julian was Vice President and Research Director. From 1971 until joining Bloomingdales, Julian was Vice President and member of the Executive Committee with another New York area retailer. . . . **Edwin Hiam** was elected Secretary of Boston's Museum of Science at a recent annual meeting of the Board of Trustees. Edwin is affiliated with the investment firm of Foster Dykema Cabot and Company, Inc., in Boston.

**Reginald Stoops** is now a business and engineering consultant, specializing in reinforced plastics. He is spending most of his time in Minneapolis where he is working with a grain company. Reginald is involved with a firm that fabricates very large structural plastic parts. He is enjoying the work and life in Minneapolis. . . .**Dan Fink** was quoted by the *Christian Science Monitor* in an article about manufacturing in an orbiting space station. Dan said, "The commercial sector is at least as concerned about the business, legal, and administrative problems as with the technical difficulties of manufacturing in space." He said full-scale manufacturing in space is unlikely to begin before the 1990s. Products will be small and sophisticated, because of the huge transportation costs.

Space offers several advantages such as not having to use a container or surface to support something. On earth the container that is used is a source of impurities. Molecular forces like cohesion and adhesion will replace gravity as the strongest environmental force to be contended with in space processing. Casting and drawing methods will be changed to benefit from the different environment.

**Herb Marcus** won the honors in the first Marion, Mass., to Bermuda race. The racing rules favored cruising yachts over racing machines, and Herb's boat *Silkie*, a five-year-old Tartan 41 was first to finish, first in class, first overall, and first "shorthanded" (boats with crews of four or under). Herb missed a calm spot in the Gulf Stream that frustrated most of the other 106 yachts.

As a Rhode Island resident I was pleased to see that **Warren King**'s consulting firm is negotiating with the Road Island business community's Public Expenditure Council (R.I.P.E.C.). R.I.P.E.C. has a proposal from Warren's firm which would have the firm guide a task force of 36 Road Island business executives in a 12-week study of efficiency in the state's government. Road Island's governor is urging the business community to fund the $175,000 review and to provide 36 executives to help conduct it. Henry D. Sharpe, Chairman of the Board of Brown and Sharpe, would lead the project. Warren's firm has done similar studies for 24 other states.

**George Clifford**, Chairman of our 30th Reunion, showed slides of Chatham Bars Inn to the reunion committee at their meeting on November 16. Comments on the slides consisted of compliments about the bathroom fixtures and statements that the beds looked comfortable. There was an interest in the rocking chairs on the porch, and this was matched by the pleasant anticipation of playing tennis on a red and green turf. As reported earlier, the committee is planning two days of the reunion at Chatham Bars Inn.

Attending the November meeting were Jean and **Jack Juechter**, Joan and **Al Seville**, Dorothy and **Norman Seltzer**, Jean and **Milton Slade**, Rose and **Leon LaFreniere**, Gloria and **Sonny Monosson**, Nancy and **Don Noble**, and **George Clifford**. The meeting was held at the M.I.T. Historical Collections, a museum containing many examples of early scientific equipment and photographic histories. During the discussion of the program for our 30th Reunion Sonny suggested that a repeat of an earlier Nature Walk on the beaches near Nauset should be scheduled. He also thought there would still be some bicyclists among our classmates.

The fall newsletter of the Association of M.I.T. Alumnae brought the sad news that **Gertrude Burbank** has died. Gertrude had her own architectural practice in Suffield, Conn., for about five years, giving it up about ten years ago. She had practiced architecture in the Hartford, Conn., area for many years. Her husband and four children survive her.

**Henry J. Cunningham** died in Japan. Henry has lived in Japan for many years. At first, he was an officer in the Tokyo office of Bourne Associates. Recently, he was Vice President of Pacific Architects and Engineers of Los Angeles, in charge of their Far East operations. His wife, Fumie, a daughter, Mie, and a son, Paul, live in Kamakura. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

# 50

**William N. Johnston** was elected President of the American Bureau of Shipping at the semi-annual meeting of the A.B.S. Board of Managers in September. Mr. Johnston assumed the office on November 1. He became the 12th President of the International Ship Classification Society in its 115-year history. Mr. Johnston is a member of the Society of Naval Architects and Marine Engineers, the American Welding Society, and is a Fellow of the Royal Institution of Naval Architects and the Institute of Marine Engineers. He is a member of the Union League Club of New York, and the Army and Navy Club of Washington, D.C. He is also Vice President of A.B.S. Computers, Inc., a wholly owned subsidiary of the American Bureau of Shipping. Mr. Johnston and his wife, Kay, live in Short Hills, N.J. They have four children. We re-

gret to announce the death of **Diran C. Basmajian** on September 2, 1976. — **John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

# 53

Fellow Classmates: **Dick Lindstrom** reports that 92 of our classmates have already indicated their intentions to attend our 25th Reunion (which is next June in Cambridge). **Joe Mullen** is doing his best to win the "longest distance" award by "jetting" all the way from Hawaii; a number of others intend to come from far away places such as California, Texas and Florida. Should any of you have suggestions for activities or organizational details, you can send them to Dick (at 18 Henzie St., Reading, Mass. 01867) or pass them on through me. (So far, the plans look magnificant — with a cocktail party at the President's house (that is, Wiesner's), an evening at the Pops, a dinner banquet at the new posh Hyatt (which adjoins the M.I.T. Campus), a harbor cruise and clambake, etc., etc., etc.

Ole **Bill Gouse** left his E.R.D.A. post (Deputy Assistant Administrator for the Fossil Energy Program) in early October to become Chief Scientist of the MITRE Corporation. (I should warn you that Bill *both* lives and works in McLean, Va., the town which harbors our nation's most famous house-of-ill-repute. Oh, you know which one: the C.I.A.) Bill and Jackie's son is now a sophomore at Georgia Tech in the mechanical engineering cooperative program and spends every other quarter at the David Taylor Model Basin; their daughter is a first-year graduate student in chemical engineering at M.I.T. . . . And, while speaking of MITRE, **Wolf (Bill) Haberman** is still there (after over 16 years); for the past several years he has been project leader on programs connected with physical security equipment and systems for U.S.A.F. and Nuclear Regulatory Commission. He keeps active at home (with his wife, Berna, and four youngsters from 15 to 22), and as a member of the Framingham Finance Committee and the Framingham Republican Town Committee. . . . I suppose that plug requires me to grant equal space to any members of the Framingham Democrat (sic) Town Committee. (If you guess when or where I learned that clever wording, you win a free phone call from **Jay Berlove**.)

**Al Lazarus** was just appointed as Associate Dean of Student Affairs and Director of the Office of Freshman Advising at M.I.T.; however, he will continue to work half-time (as a senior research scientist) at the M.I.T. Center for Space Research, conducting research on solar wind. Al finished his doctorate in high energy physics at Stanford, diddled around for a year at RAND Corporation (p.s., my wording, not his), then joined the M.I.T. faculty in physics for the next ten years. Plus he spent a year at the N.A.S.A. Headquarters in D.C. as a staff scientist in high-energy astrophysics. . . . **Clifford McLain** is now Deputy Director of the Defense Civil Preparedness Agency in Washington. Prior to this appointment, Clifford had been Director of the Army Ballistic Missile Defense Program; before that, he had been the Program's Director of Technology. Earlier (back in the late 1950s) he worked under Von Braun in the pioneering missile development programs in Huntsville, Ala., and then in the follow-on missile programs of the 1960s until 1972 in the Pentagon. Nor should I fail to mention that Clifford has invented such disparate devices as a high-speed oil skimmer, a crash recorder for light aircraft, and a yarn (no, *not* yawn) flaw detector. . . . (*Ed:* Berlove, where are you? I'm in desparate trouble; need new joke material badly. Please call — at your expense!)

In mid-October, **Kent Hansen** (who has been on the M.I.T. faculty since 1961) learned a little more about politics and the power of the environmentalists; at that time the Senate Environment and Public Works Committee voted against confirming his appointment (by *the* President) to a seat on the Nuclear Regulatory Commission. According to the *Wall St. Journal*, Kent ". . .was opposed by environmentalists as being too pronuclear." Oh, yes; it *also* seems he admitted his opposition to Jimmy's stand against building a nuclear breeder reactor project at Clinch River, Tenn. (*Ed:* Kent, please respect my rights to be the first to publish a book entitled, *How Not to Succeed in Washington.*) — **Martin Wohl**, Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

# 54

Two interesting articles from the *Boston Globe* were brought to our attention recently involving classmates who are engaged in energy conservation endeavors.

**Stan Kolodkin** with three other principals formed a new company called Xenergy in Lexington, Mass., in February, 1975. Stan, who graduated from Course VI (Electrical Engineering), told the *Globe* of a number of projects that his new firm is working on. In one case a homeowner received a printout showing that a $12 investment for two reduced-flow shower heads would yield first-yar savings of water cost and fuel of $91.82, or a payback period of .1 of a year. The computer, of course, made this data available very quickly. Stan mentioned that few property owners realize that substantial, often spectacular, energy cost reductions are easily available and sometimes with modest investment. In an older downtown office building in Boston, the owner was paying approximately $600 a month during the summer for steam for hot water. Calculations showed that this was excessive and subsequent investigation revealed a leak. The first year savings amounted to $3,800 or a 646 per cent rate on investment and a payback period of two months. A Midwestern university with a huge campus had a $12,000,000 annual energy bill. A preliminary investigation showed that 10 per cent of the steam traps were old and defective. Stan's company projected that they could save at least $200,000 a year by correcting or replacing these steam traps. Further investigation showed that 40 per cent of the steam traps were faulty, and it looks now as though they can save approximately $800,000 a year. Xenergy is studying energy conservation in a number of industries including automobile dealers, laundries, retailers, and banks. By working through trade organizations they have been successful in reaching greater numbers of businesses with excessive energy costs. Energy costs are certainly a large cost factor in many of our lives today and it sounds like Stan and his associates have found themselves a very fertile field. We wish them every success.

A second *Globe* article featured another of our classmates, **John Zvara**, who is a Course XVI graduate. John is President of Aerospace Systems, and his company recently formed a subsidiary called Technology Properties Trust. This subsidiary is currently constructing a building in Burlington, Mass., that is a first in the nation because all its heating and cooling will be supplied from a combination of solar collectors and a back-up system of a heat pump utilizing well water. To enlist nature's help a step further, the developer is designing a one-Kw generator sufficient to run one of the heat pumps. The U.S. Energy Research and Development Agency thinks enough of the project to allocate $171,411, including it as one of 80 demonstration programs in 33 states. Two local banks are participating in a $600,000 mortgage for further financing of the project. John Zvara indicated that the entrance of his firm into the energy field is a logical outgrowth of the knowledge that they accumulated while wrestling with space problems. The firm's goal is to develop sophisticated control systems for the energy market. It sounds like John is into something really interesting and challenging, and obviously this is the kind of direction and effort that must be made if our country is to solve its energy problems in the years ahead. We wish John success.

Early in October a number of our classmates got together one evening at the M.I.T. Alumni Office and, utilizing a telethon, talked to many of our classmates throughout the country. The purpose of the telethon was to drum up interest for our 25th Reunion, which will be held at M.I.T. in June of 1979. We tried to contact classmates active in a particular organization, group, or fraternity during our days at M.I.T. It was hoped that these individuals would contact other classmates that they may not have seen or talked to for many years and possibly set up a mini-reunion, combining it with our 25th. Approximately 20 of our classmates throughout the country who were contacted during the telethon expressed interest and enthusiasm in this approach, and agreed to contact some old friends. If any other of our classmates reading this article would like to help us make our 25th Reunion a memorable occasion, please contact one of our class officers or write to our secretary in care of the address below. The telethon was conducted by **Wally Boquist**, **Dean Jacoby**, **Bob Warshawer**, **Chuck Masison**, and **Lou Mahoney**. These fellows report that the telethon was a real joy as many old friendships were once again renewed.

On October 28 a number of our local classmates were invited to a very entertaining evening at **Wally Boquist**'s interesting home in the woods of Lincoln, Mass. **Dave Howes**, **Bob Rohner**, **George Schwenk** and **Lou Mahoney** had an enjoyable evening talking over old times and meeting many of Wally's friends and business associates.

**Joe Blake**, our class agent, has informed us that another telethon is being planned for mid-November to build up interest among our classmates for our Alumni Fund. It is traditional for each 25th year reunion class to make a substantial gift to the Institute to maintain a strong and active educational program. — **Dave Howes**, Secretary, Box 66, Carlisle, Mass., 01741; Assistant Secretaries: **Chuck Masison**, 76 Spellman Rd., Westwood, Mass., 02190; and **Lou Mahoney**, 6 Danby Rd., Stoneham, Mass., 02180

# 56

**Bill Northfield** is President of Micon Industries, a manufacturer of mobile computer terminals in Oakland, Calif. Bill had been a founder and president of Computer Devices, Inc., in Burlington, Mass. He and Sandy have three children. . . . **Wendyl Reis** has made another shift from staff to line positions — this time from Director of Planning for ACF Industries in New York City to Assistant General Manager and Director of Operations at the AFC Valve manufacturing plant in Houston, Texas. Wendyl had a corporate planning job with Sprague Electric, prior to becoming a Plant Manager for Sprague in N.H. He reports that the change from a one and one-half hour commute to New York City to a ten minute commute in Houston is a great improvement for family life, but that now it's much easier to drop by the plant on Saturday morning or otherwise.

**Emmanuel Papadakis** is Supervisor of Non-Destructive Inspection Technology at the Ford Motor Company research staff. . . . **Henry Hebeler** is Vice President of Boeing in Seattle, and General Manager of their environment and energy-related products. He is involved in building water treatment plants, power plants, and E.R.D.A.-sponsored research. . . . **Donald Koffman** has returned to the G.T.E. Labs in Waltham, Mass., after two years as co-founder of Aristonics Corporation, a small firm specializing in computerized telephone controls. At G.T.E. Don is developing electron beam lithography equipment for high resolution reproduction of integrated circuit chips. He and his wife have two boys, and live in Winchester, Mass. . . . **Richard Quinn** was named Staff Vice President at the RCA Laboratories in Princeton, N.J., where he had been Director of Financial and Technical Services. — Co-secretaries: **Bruce Bredehoft**, 7100 Lanham Ln., Edina, Minn. 55435 (tel: 612-941-7438); **Warren G. Briggs**, Northeastern University, Deree College, Box 472, Athens, Greece (to July, 1978)

# 57

I recently heard from **Terry McMahon**. His ten year old engineering practice (McMahon Techno-

logy Associate) is keeping him busy and I imagine prosperous. Terry and his wife, Rosemary, and their two children, Timothy, four, and Kerry Rose, two, moved into their first home in Leonia, N.J., two years ago and are very happy. Terry is keeping busy with some outside interests as well. He recently was Chairman for the Hotel and Meeting Room Conference in N.Y. of the American Industrial Chemical Engineers. He's also Treasurer of their N.Y. area. Last year and again this, he was President of M.I.T.'s Northern N.J. area and was also on the Executive Committee for them in N.Y.

**Martha K. Norman** reports: "I've come a long way from chemistry. I'm now a real estate broker in La Jolla, Calif., divorced, and have two children, aged 9 and 12."

Now that women are being recognized as economic assets, costly to replace, we are seeing advertisements for insurance for women. On the sales side, **Robert Palter**, is interested in hiring female life insurance agents. He has returned to Boston to rebuild one of Boston's leading agencies. If you are interested, contact AMITA or Bob himself at the Palter Agency, P.O. Box 2487, Boston, Mass. 02208. Bob's own background is in civil engineering, so don't hesitate to pursue this because of your own non-insurance background.

My final news is to share with you the information that **Richard W. Bohlen** was named Vice President and General Manager of the Municipal and Utility Division of Rockwell International Corporation. In his new post, he will be responsible for total operations and business performance of the Municipal and Utility Division, which serves the meter, regulator, and pipe repair equipment needs of gas and water utilities throughout the world. With Rockwell since 1962, Bohlen joined this division 15 months ago from Rockwell's corporate staff where he held the position of Business Strategy analyst. Well, that's all for this month.

We sincerely wish you and yours a healthy and happy holiday season and look forward to hearing from you. You can call my office and leave any news or write to me. N.Y.C. Health & Hospital Corporation, 125 Worth St., — Room 510, New York, N.Y., 10013. Tel: 212-566-8060. — **Fred L. Morefield**, Secretary, Apt. 6A, 285 Riverside Dr., New York, N.Y. 10025

# 58

"It's hard to believe," **Paul Rothschild** remarked in a recent letter, "that our 20th Class Reunion is nearly upon us. I think the years must only have 200 days in them now. Rona and I very much enjoyed the 15th at Martha's Vineyard and we're looking forward to returning there in June." Well, folks, the Reunion Committee couldn't agree more so mark your calendars now. Reserve June 9 to 11 for a fabulous weekend at the Harbor View in Edgartown on Martha's Vineyard. You and your wife (or husband or friend or pet crocodile of whatever) need a break, a reward for those years of hard labor, a time to get away from it all. But, you won't have to relax unless you really want to because the Reunion Committee has activities planned to keep you on the go non-stop. Our Sports Chairman, **Glenn Strehle**, has expanded the activities from tennis, golf and bike-riding to include jogging and a mini-marathon, chair-rocking and a sailing cruise for all. Gourmet **Gary Fallick** is attending to the menu so that the tired need not go hungry. A keg of beer will again be on tap at poolside to refresh the weary. Evening entertainment plans are in the hands of **Tom Magliozzi**, whose bluegrass band may provide some foot-stomping, sing-along sounds for Friday night. Registration matters are, of course, being handled by attorney **Martin O'Donnell**. And, in "due" course, you'll be hearing from **Steve Hadjiyannis**, Reunion Treasurer, about class dues and other monetary matters. Everything you wanted to know about the Reunion, but were afraid to ask, will be told by **Dick Barone**, Publicity Chairman. Other able hands on board the Committee include **Pete Ricupero**, **Dick Rosenthal**, **Frank Tahmoush**, **Bob Ricci**, **Pete Lynch**, and **Bob Cooper**. At the moment, **Mike Brose** is serving as Chairman of the Reunion Committee. Call any of us if you have suggestions or questions about the Reunion. Hope we'll see you all there.

At the Charlotte Service Center of Joseph T. Ryerson and Son, Inc., **Ted Calves** was recently promoted to the position of General Manager. He joined Ryerson in Philadelphia after graduation and was transferred to the Charlotte operations in 1966. Ted and his wife, Alexandra, have two daughters and are living in Charlotte. . . . **Ken Whipple** has been elected Executive Vice President-Insurance and Special Financing Operations at Ford Motor Credit Company. Previously, Ken was Vice President-Finance and has held several other positions including Manager of the Management Services Department, and Assistant Controller at Ford. He has been with Ford since graduating from Tech. . . .**John Thorpe** has recently attained the rank of Professor of Mathematics at the State University of New York at Stony Brook. He received his Ph.D. at Columbia University and is co-author of a textbook on differential geometry and the author of numerous research articles on differential geometry and general relativity. John and Marilyn live in Port Jefferson, N. Y. with their two sons.

**Edwin Pearson** has been appointed Chairman of the University of New Haven Undergraduate Criminal Justice Program where he has been teaching since 1975. He received his J.D. from Georgetown University Law Center and his L.L.M. degree from Harvard Law School.

We extend our sympathy to the family of **Charles Wernlein**, who passed away this fall. . . . **John McCarty** was selected by Stanford University to be a Sloan Fellow this year. John has been Assistant Chief Engineer for the Martial Space Flight Center's Space Shuttle Main Engine Office where he has worked since 1963. John and Sandra have four children and their home is in Huntsville, Ala. . . . In addition to his Reunion activities, **Dick Barone** is also serving on the Educational Council at M.I.T. Currently, Dick is an independent consultant and has formed his own firm, Materials Consultant Engineering.

That's all the news for now. Think Reunion! — **Michael E. Brose**, Secretary, 30 Dartmouth St., Boston, Mass. 02116

# 60

Our thanks to **Dick Davidson** who has called our attention to **Jerry Woodall**'s recent accomplishments. Jerry is at the I.B.M. Thomas J. Watson Research Center, and he has developed a new solar cell manufacturing process ("etch-back epitaxy") which is much simpler than previous methods of making high-efficiency gallenium arsenide cells. As reported in *Optical Spectra* magazine, the energy conversion efficiency of the resulting cells is close to the theoretical limit for the materials which are used, and Jerry's work is an important step in lowering the cost of solar energy. Incidentally, Dick still heads Radmar, Inc. in Northbrook, Ill., and he has just become a Scoutmaster, in partial atonement for "quitting after Cub Scouts when I was a boy." That's quite a responsibility but Dick indicates that he is enjoying it.

**Robert Wolf** writes that he has completed a sabbatical at M.I.T. and has returned to Harvey Mudd College, where he is Professor of Physics and Director of the Freshman Division.

Another batch of missing alumni follows: **Evans-Lutterodt**, **Faillace**, **Feinbaum**, **Fishman**, **Fletcher**, **Fuchs**, **Ganz**, **Garcia Mendoza**, **Gavales**, **Ghais**, **Golston**, **Graham**, **Griffin**, **Harper**, **Hoffman**, **Hubbard**, **Itzkowitz**, **Jensen**, **Johnson**, **Karper**, **Kildee**, **Kiley**, **Koepke**, **Krawetz**, and **Kresch**. Drop a line if you have any idea where these people may be hiding.

**Ray Harlan**, our Class President, has sent a reminder regarding the 1978 Alumni Fund. Your participation in the Alumni Fund is as necessary as ever to help maintain the "excellence that is the Massachusetts Institute of Technology." — **Robert F. Stengel**, Secretary, 329 Prospect Ave., Princeton, N.J. 08540

# 62

**Stephen Burns**, an electrical engineer, currently directs the Microprocessor Engineering Laboratory as well as serving as Technical Director of the joint Harvard-M.I.T. Biomedial Engineering Center for Clinical Instrumentation. . . . **Henry N. McCarl** has received a Fulbright-Hays Grant to teach Energy, Resource and Environmental Economics at the Academy of Economic Studies in Bucharest, Rumania. He will remain there until February, 1978, when he will return to his position as Associate Professor of Economics and Earth Science at the University of Alabama in Birmingham. He is currently serving as Secretary of the Birmingham Planning Commission, Chairman of the Zoning Advisory Committee, and member of the Zoning Board of Adjustments. Henry, his wife Louise, and oldest daughter Kathy, 13, raise and show pure-bred Dachshunds and Beagles in their spare time. — **Gerald Katell**, Secretary, Watt Industries, Inc., 1623 26th St., Santa Monica, Calif. 90406

# 63

Short column this month. Only one news flap, one item borrowed from another newsletter, and a bit of news I scrounged up myself. The winter seems to bring a dry spell in news — hope this dry spell is less severe than the one afflicting the state of California.

Our one correspondent is **Meg Hickey**. Meg is Assistant Professor at the Massachusetts College of Art, teaching architectural technology. She is also a design specialist for the Cambridge Redevelopment Authority, doing architectural work for city-wide urban renovation programs.

A brief note borrowed from the AMITA (Association of M.I.T. Alumnae) fall newsletter informs us that **Chris Huk Jansen** has joined Millipore Corporation as an analytical manager. . . .My final bit of news was garnered in a phone conversation with **Frank Model**. The Models just completed their first year in Ann Arbor, Mich., after living for ten years in New Jersey. They are enjoying being in the atmosphere of a college town again. Frank is Vice President of research and development at Gelman Instruments, and is charged with developing new products in the area of filtration and clinical diagnosis. Spouse Sue is back in school full time pursuing a Ph.D. at Michigan in the fields of social work and sociology. Pretty soon it will be Dr. and Dr. Model.

That's it for the month. Remember, in this space no news is *not* good news. Get inspired — put quill to paper — drop me a line. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92715

# 64

Greetings '64. The well has run dry! We all need to take *both* of President **Dave Saul**'s recommendations to heart. First, contribute to Challenge '78; second, send some news to your Class Secretary (thanks for the plug, Dave).

I wrote our last installment in Munich. I'm home for this one (a week late as usual), but that's only because I'm between trips. Since Munich, it has been a week at Cape Cod for Autotestcon 77 (where I co-authored a technical paper) and a week in the wilds of Pennsylvania (Warminster) and New Jersey (Lakehurst). Marlene came along on the Cape Cod trip (and the kids stayed home!) so that was a really pleasant business trip. When we moved to the Washington area, it was understood that 30 to 40 per cent travel came with the turf; what was not understood was that virtually all of it occurred in two-month travel impulses, one in spring and one in fall.

On one of those rare recent weeks which found me home, we met **Paul Mar** at a P.T.A. meeting. One of his and one of ours are in third grade together. Paul and his family have recently relocated from the Far East (talk about changing jobs!) to the Washington area, and he has gone to

work for the General Electric Company.

We did get a little (very little) class news. **Jack Moter** reports that he is still working for Raytheon in Bedford, Mass. He had his best year yet in tennis last year, pulling down the number ten (10) slot in the Men's Singles Ranking for New England. As Jack put it, "Having spent the last 12 years working on forehands and backhands, thought I'd concentrate on a few 'other' strokes. Results: Jonathan Bryan Moter, born May, 1977. First addition to family. Juta was happy to give up guidance counselling." Congratulations, Jack and Juta!

Professor **John William Morris, Jr.**, Professor of Metallurgy, Department of Materials Science and Engineering, University of California, Berkeley, has been selected to receive the 1977 American Society for Metals Bradley Stoughton Award for Young Teachers of Metallurgy. The award was presented at the Society's Annual Awards Dinner, on October 26, 1977, during the Materials Show and Conference in Chicago.

**Bruce Hopkins** has been named President and General Manager of Hamilton Foundry Division, Hamilton Allied Corporation, both of Hamilton, Ohio. Bruce will continue to serve as Corporate Vice President — Finance and Administration. The announcement of the promotion and new responsibilities was made by Peter R. Rentschler, President and Chief Executive Office of the parent corporation, who said "the promotion of Hopkins was well deserved and would create a more efficient organizational structure." Since leaving M.I.T. with his B.S.M.E., Bruce has earned an M.B.A. at Dartmouth in 1971, where he ranked first in his class. The Hopkins family (two children) resides in Hamilton, where Bruce is active in civic and community affairs, charitable endeavors, and church activities, as well as having taught at the Hamilton and Middletown campuses of Miami (of Ohio, presumably) University.

That wraps it up for this month. Send news and read about *your* lives; don't send news and read about mine. Support the 'tute! Write your Class Secretary. Enjoy your holidays! Ciao! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

# 65

**Cliff Weinstein** reports a new son, Jonathon, born March, 1977, to join the Weinstein's daughter Dena, 3. Cliff is now Assistant Leader of the Digital Processors group at Lincoln Lab. Cliff's wife, Georgia (Ph.D. '72), is lecturer in Chemistry at Boston University. . . . **Walt Miller** got his M.D. from Duke, recently completed two years as a post-doctoral fellow in biochemistry and is now finishing a fellowship in pediatric endocrinology. He hopes to stay in California on the faculty and continues to enjoy the fruits of single life and California vineyards.

**John Holdren** has co-authored a new college textbook, *Ecoscience*, with Paul and Anne Ehrlich. John has co-authored two previous books on energy and environmental science as well as some 60 papers. . . . **Allen Hillman** has been appointed a field marketing engineer for GTE Sylvania. Major **Charles Seniawski** is attending the Armed Forces Staff College at Norfolk, Va.

Finally, from **Bill Roeseler** comes the comment: "How about shipping grain to Asia and returning with cars from Japan at twice the speed of the wind without burning fuel." Unclear whether Bill was proposing this or had just experienced it, though my guess is the latter.

Having lost our St. Bernard, the Hoffers have not been without pets. We are now sharing our home with three cats, approximately four hamsters and two hermit crabs. It is a gray, bleak mid-November day, but not half so bleak as next month will be if I do not get some Class news! Please write. — **Edward P. Hoffer**, M.D. Secretary, 12 Upland Rd., Wellesley, Mass., 02181

# 66

**Judith A. Perrolle** writes that she is finishing her Ph.D. dissertation in Sociology at Brown University. She is still on the Educational Council and Visiting Committee for the Humanities Department and is about to begin serving on the Alumni Council. . . . **Thomas Percer** celebrated the birth of his third boy and recently went into private practice in Long Beach, Calif., after working in group doctor practice.

**Larry Schwoeri**, our Class Agent, has been transferred to El Salvador for a year. In his absence, **Joe Rife** has agreed to be Class Agent. . . . **David P. Vanderscoff**, who graduated with an S.B. degree in mathematics, joined New York Life Insurance Company in 1966 as an Actuarial Trainee. After a series of progressive career movements and obtaining his M.B.A. from Adelphi University in 1975, he is now proposed for election as President and a Director of Northern National Life Insurance Co., effective January 1, 1978. — **Paul Rudovsky**, Secretary, 340 East 64th St., New York, N.Y. 10021

# 67

**Eric Johnson** is assistant Director of the Industrial Liaison Program at M.I.T. . . . **Richard Cunningham**, a 1970 graduate of Duke University Law School, is an attorney in Stamford, Conn. He has been promoted to Captain in the Army Reserve. . . . **Rick Goeld** is with Motorola Semiconductor Products in Austin, Tex. . . . **Robert Gerstle**, M.D., has left private pediatric parctice and is now on the full-time staff at the Baystate Medical Center in Pediatrics in Springfield, Mass. He is director of the Cystic Fibrosis Clinic and developing a neuromuscular disease clinic for western Massachusetts. . . . **Richard Coulter** returned in September from an assignment with RCA in Stuttgart, Germany. He lives in Carlisle, Mass., with his wife Sally and their 2-year-old Amanda and is awaiting the birth of their second child in March. . . . **Barry Watkins** graduated from Boston University Law School in 1976 and is employed by the City of Rochester (N.Y.) in the Corporation Counsel's office. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

# 69

**Arturio A. Rosales** was named an Assistant Director of the Industrial Liaison Program at M.I.T. beginning July 1, 1977. Arturio lives in Natick with his wife and three children. . . . **Carolyn Gissen Dedrick**, is back in the Boston area (living in Lexington) in her last year of radiology residency at Mass. General. Her husband Dan, '66, is in the Anesthesiology Dept., also at M.G.H. Their son Benjamin (born August 29, 1975) also resides in Lexington.

**Bruce L. Heflinger** is back at M.I.T. working on his Ph.D. in E.E. He spent several years as a mechanic and bulldozer operator on the Alaskan pipeline. Bruce looks forward to finishing his doctorate in time to return to work on the natural gas pipeline. . . . **Henry G. Baker** just started as Assistant Professor of Computer Science at the University of Rochester in Rochester, N.Y. His wife Carolyn graduated from Boston University Med School in May, 1977, and started her residency in Rochester at Strong Memorial Hospital. Happy New Year everyone. — **Peter Peckarsky**, Secretary, 950 25th St., N.W., Washington, D.C. 20037

# 71

**Robert D. Marshall, Jr.** (alias Crew Jock) writes: "I graduated from Georgetown University Law Center and am employed as a legal associate with the patent law firm of Wenderath, Lind & Ponack in Washington, D.C., working on patent prosecutions in electronic inventions (representing clients who want patents before the patent office)." Robert passed the examination for qualification to practice before the Patent office (a significant accomplishment). He also passed the Virginia bar exams. As a wage earner, he moved out of a basement apartment and turned in his 1969 TV for a better model.

**Laura Middleton** wrote a long letter. She finished a master's in biochemistry at the University of Maryland and is now in her fourth year at the University of Michigan medical school in Ann Arbor. Some M.I.T. folks present are **Janet Arey Sweetman** and Eric, Rick Johnson, '68, and his wife, Cathy Doherty, Joanne and Art Cole, '69, and their daughter Gwen, and Leslie and Dave Newman, '69. Janet and Eric are still working on their Ph.D.s in environmental chemistry and physics. Rick and Cathy have just had a boy, Brian. Susan Fuhrman, who is in Laura's medical school class, is married to Larry Lasky, '72. I'll quote the rest of her letter: "This August I went back to Boston to do a senior rotation in neurology at Massachusetts General Hospital under David Poskanzer. I spent ten days living in McCormick for old times sake, then spent about a week with Janet Sweetman's parents in Quincy and the rest of the month in Cambridge with other friends. Being back at M.I.T. was like being in a ghost town. All the buildings were the same but the people were unfamiliar. Sitting in McCormick's penthouse writing post cards, I had the eerie sensation that ten years had evaporated and I was pulling an all-nighter to finish a paper for 21.015. The smells are the same, the elevators have the same familiar clatter. There are a few subtle changes: a few new buildings, a little fraying in the upholstery, the kitchens we argued about installing are in the old tower, the carpet has disappeared from the new tower lounges. The towers are called 'West and East' instead of old and new; the word 'coed' seems to have fallen out of favor. I really didn't think it was insulting and must admit I was rather proud of it. The McCormick desk captain is now allowed a key to the circuit breaker boxes — no more calling heat vent at 3 a.m. for a blown fuse. The Institute is investing in a number of works of what is termed art, which have not endeared themselves to the student body. One of them looks like the leftovers after Calder finished the great sail, slapped together at random. The dollar bill remains over the cashier's office. By far the most insidious changes is the disappearance of the springfield oval; it seems completely gone from the 'Tute grounds. It was found at the Mass. Mental Health Center at Boston City Hospital." Laura saw Glenn Wargo, '70, who is moving from the slum of Main St. to a new place in Somerville, having endured stolen stereos, car seats, etc.

Radia Perlamna, '73, and Mike Speciner, '68, have just bought a house in Arlington with all the quarters Mike saved by riding his bike to work instead of taking the subway. Professor Kemp reported his book will be done in 1980 but will be unlike the familiar Kemp Notes. . . . **Mark Pasternak** was at M.G.H. as a senior resident. . . . **John Halperin** and **Steve Hauser** are both in neurology. . . . **Ed Nowak** is finishing his Ph.D. while his electric train has taken over one room and gone over to the next.

**Scott Ramose** writes that he and Joan have settled in Seattle where he is working with N.O.A.A.'s National Marine Fisheries Service as a research chemist in the National Analytical Facility doing analyses of petroleum hydrocarbon samples obtained in the Puget Sound and Prince William Sound areas. He's also playing amateur soccer and doing forest treks. Joan has completed her master's in social work in community organizations, specializing in health planning. For over two years they were in South America, Joan as a Peace Corps volunteer in Brasil, as a nutrition educator in a Rio slum and Scott as a water pollution consultant in the Guanabar State Sanitary Engineering Institute. They became fluent in Portugese and acclimated to the 40C. and higher temperatures. They enjoyed carnival and futebol (soccer) and traveled through Brasil, including a boat trip through the Amazon, sleeping in hammocks, touring all of the continent south of the equator. They backpacked in Argentina's lake country above 15,000 ft. near La Paz and along

the Inca trail to Machu Picchu. They spent their last three months enjoying the food and culture of Bolivia, Peru and Ecuador. They saw **Mike Gilmore** who was on his way to a roundthe-world trip. They have bought a small house in Seattle and would enjoy any visitors. They would especially like to hear from old Burton Third Bombers. (Scott Ramose, 7303 23rd Ave. N.E., Seattle, Wash. 98115).

**John Welch** writes: "after spending five years in the Navy as an aircraft maintenance officer, I am employed at G.E.'s Aircraft Enginer Group in Lynn, working on logistics support analysis and maintenance for the f404 engine for the Navy F-18. . . . **Peter G.H. Hwang**, writing under the name of Frodo Baggins, suspects we have all been coopted. In 1971 he spent the summer hitchhiking and came back to graduate. He organized the Urban Vehicle Design Competition with Vince Darago, '72, and had a good time. He was field engineer for G.E. in New York and Washington, D.C., where he was with **Paul Palmer** (Captain Bligh of the Baker House dining staff) who is now building his ferrocement sailboat on the shores of the Chesapeake. Pete completed business school at Stanford University and worked for the F.E.A. in Washington; then for G.E.'s marketing and strategic planning consulting service. He's now living in a group house between New Haven and Bridgeport on the beach of Long Island Sound. He visited Paul Palmer,Vince Darago, '72, Joseph Clift, '72, Faruq Ahmad, '72, and **Alex Monty**.

I'm glad to see our classmates are beginning to write. I would encourage more of you to let me know what you are doing — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Tex. 77833

# 73

Welcome once again to the world of '73dom. Only a few letters to grace this month's edition, so let me reiterate a plea from the Alumni Office: our reunion is in six months (oh, yes, it is!), and volunteer assistance is desperately needed. Let's help by calling up today.

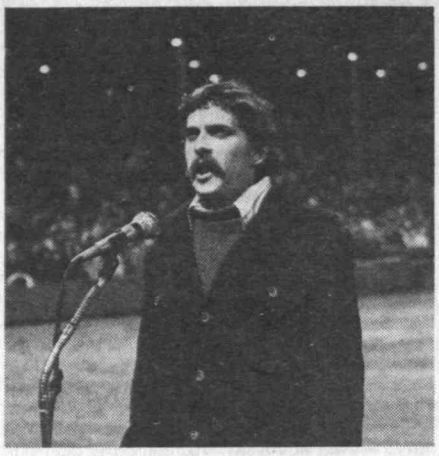
**Dennis Tully** writes that his wife Patricia and he are preparing for 18 months of research in the Sudan on cooperative labor systems, from which he will write an anthropology dissertation. . . . **Steve Altchuler** is finishing up his Ph.D. at the ol' 'tute in nutrition. Steve was married to "Sam" Frydman in the summer of 1976. . . . Long letter award goes to **Cha-Rie Tang**, who, after encouraging classmates to write, says "I have received my M.Arch. from University of Colorado, and am happily working in an architecture firm. My husband, **Bruce Hubbard** and I bought a house in Pasadena, where he is finishing his Ph.D. at Caltech in biology. He has set up a nice woodworking shop and is making fine furniture. I am still dancing and trying to set up a multimedia dance company. While in Denver, I was a member of the Cleo Parker Robinson Dance Ensemble, which represented the U.S. in Festar at Lagos, Nigeria. This summer I danced at Disneyland."

Word has been received that **Ralph Von Hagen** passed away on September 17, 1977. All of Ralph's brothers at Sigma Chi and the rest of the class extend their sympathy to his family.

For those of you who missed the Red Sox-Toronto game of September 26 to hear yours truly lightvoicedly sing the National Anthem before the game missed something. . .well, interesting. After last month's notes to that effect, I was swamped with doubting letters. The photograph at the margin will be adequate proof. Good night, **Tony Scandora**, wherever you are. — **Robert M.O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

# 76

News — from the mails and divers conversations! **Mark Suchon** writes that "B.F. Goodrich sent me to Bogota, Colombia, for seven months to work in the factory there. Returned to the States in August, and am now sales engineer for missile and anti-submarine warfare products." But tell me, did you learn how to speak Spanish? . . . And from **Chris Garrod**: "Just finished enjoying a two-month vacation hitch-hicking coast-to-coast and back. Hitchhicking has to be the finest way to see this country and the people who live elsewhere. Presently, I am beginning my second year of studies toward my doctorate at Scripps Institute of Oceanography. This place is harder than M.I.T. ever seemed to be." I can not imagine what Scripps must be like — wasn't the 'tute hard enough?



*Robert Sutton, '73, sang the National Anthem before the Red Sox—Toronto game on September 26.*

A news release indicates that **Joe Tavormina**, now a graduate student in Course II, has been selected as one of two Hugh Hampton Young Memorial Fund Fellows for the 1977-78 academic year. This award is to provide financial assistance to outstanding students who have an exceptional breadth of interests and who show promise of becoming capable and effective directors of multidisciplinary projects. Well done, Joe. . . . An informant informs me that **Wolf Seidlick** is engaged to Carol Biswanger of Medford. Wolf is now working for Echolab in Burlington. He is living in Medford, although I am given to understand that he will be moving shortly.

Randomly collected news: **John Wacker** is at the University of Arizona for Graduate School. . . . **Sue Litvin** worked for Corning Glass for a year and is now back in school at Sloan. . . . **Jules Morris** does design work for G.E. at the Lynnworks. G.E. sent him to California all last winter, so he has to gear up now for the bad weather. He is going to Suffolk University Law School at night. His long week plus night school apparently are as hard as carrying a load at the 'tute. . . . **Jerry Fly** is working for Boeing in Seattle after getting an M.S. last September. . . . **Bob Dyson** is now working and living in New York City for an engineering firm. . . . **Linda Sax** is living in West Covina (outside L.A.) and is working for Honeywell in Marine Systems. . . . **Mike McIlrath** is now working in Boston. Jules wants Mike to get in touch with him as Jules has lost Mike's letter containing the address.

**Rachel Morris** is working at Teradyne in Boston as an electrical engineer. . . . **Carl Shapiro** came back from Berkeley to the 'tute to do, among other things, graduate study in economics. . . . **Linda Wolfson** is at the Woodrow Wilson School of Public Policy at Princeton. . . .I chatted with **Karen Richards** (nee Jones) and learned that she quit graduate school ("hated it") and has been working as a Computer Programmer for Data General for eight months. Also, **Claudio Topolcic** is employed at Data General.

As usual, I am starved for news. So do not be shy — write. How else may I be insured of getting news for our "Notes"? — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

# 77

Well, after failing to meet the last issue deadline I've managed to get it together enough to convey some January tidings after what I hope was a good holiday season for all. A few letters have been received by yours truly in the last couple of weeks so I'll lead off with them.

**Naoya Takuma** has located himself up in the beautiful Pacific Northwest at the University of Washington Microbiology and Immunology Department. He's already tired of weekends in the lab, and might get into something easier like management, and get back to the Boston area. Also, anyone else located in the Seattle area is invited to give him a call for a tour of various local dens of iniquity. . . . One of the busier souls has been **Walter Goodwin**, currently located in San Antonio, Tex., for Officer Training School in the U.S.A.F. This all follows a stint teaching high school mathematics where "working with restless teenagers turned out not to be my cup of tea;" enlistment in the U.S.A.F. and work as an engineering aid on the F-16; promotion after one month to Staff Sergeant; and now O.T.S. Ultimate destination is Strategic Air Command Headquarters in breathtaking Nebraska for work as a Scientific Analyst. Not bad for six months time.

Reading *Sports Illustrated* reminded me that **Frank Richardson** is attending the Iowa State Veterinary School and received an N.C.A.A. scholarship as one of the outstanding scholar/athletes in the nation. Frank is probably getting his fill of cows, horses, cats, dogs, etc., but still runs away from everyone in A.A.U. meets.

A couple of months ago I met **Carol Catalano** and **Katrina Wootton** at the Alumni Officers Conference in spacious Rockwell Cage. Carol is working for the moment at Lincoln Labs and is thoroughly enjoying not being in school. Katrina is at Yale Business School and was recently elected to the M.I.T. Corporation for a two-year term. She's commuting to crew practice from classes every night and still manages to keep up with management studies by candlelight in the wee small hours of the morning.

Also in Connecticut is **Kevin Miller** at U. Conn. med school, and with some patients could go far in the doctoring profession. Kevin makes it up to Boston on occasion to visit but I haven't managed to snare him for some first-hand news. . . . Someone that I do run into frequently is **Chris Perley**, who continues at M.I.T. in the Biochemical Engineering doctoral program. Generally busy around the area and in various I.M. sports, life as a grad student seems to agree with him. Chris is going to clue me in on some other peoples' whereabouts, which will be greatly appreciated. Anyone else wanting to help out in this respect, please do! I can use all the help I can get.

Moving onward and upward, the Army has chosen the 33 members of the Space Shuttle Astronaut Training Program, including Capt. **Charles Vehlow**. Keep a look out in the news since at the end of the two-year training program he could be on the first flight.

I've discovered that not only is **Bill Gilchrist** toiling at Sloan, he is doing his Master's of Architecture at the same time. I'm going to hire him as a consultant to help make this column a little more tolerable by introducing some levity to the news.

The other day I noticed someone decked out in a little black outfit reminiscent of an English schoolboy's uniform that turned out to be **Steve Buchthal** refereeing an I.M. soccer game. Steve was up from U.R.I for the weekend for some time off from his biochemical studies. . . . **Lampros Fatsis** is finishing up his M.S. in Ocean Engineering this year, growing a beard, and generally mellowing out around Boston.

That's it for another issue, and as I said before any helpful hints on classmates' locations and activities, writing hints, jokes, etc. will be warmly received at any time. Enjoy the new year of 1978 and write if the inclination strikes you. — **Doug McLeod**, Secretary, 11 Silvey Place #1, Somerville, Mass. 02143

*"The bridge loomed, and I hoped there wouldn't be a crush at the bottom of the stairs . . ." (Photo: Beth Marcus, '79)*

**Bonne Bell Mini-Marathon for Women: One Runner's Experience**

*by Pandora Berman, '80*

"Mom, I haven't trained in a year and a half. Do you realize how out of shape that makes me?"

"Dear, if you *walk* the course you'll finish ahead of your grandmother."

That's how I was entered in the Bonne Bell Mini-Marathon for Women. My mother, a long-distance runner and local politician, thought a fine way of getting free publicity for her re-election campaign would be for her mother, herself, and her daughter (me) to run as a three-generation team in this 10,000-meter race around the Charles River Basin.

So on Columbus Day morning, my mother, with my grandmother and me in tow, plowed her way through the press room in the Hyatt Regency hotel, passing out her press release and talking her way into being photographed and interviewed by the newspeople there.

What a sexist event an all-women's race is! This one was sponsored by Bonne Bell, a cosmetics manufacturer, whose peach-flavored lip balm was given to all participants. All the reporters asked my mother about the importance of having races for women. There are many good arguments for having women-only races, but it felt odd to be one of over 2,000 runners, none of whom were male.

At the starting line we were seeded — lined up according to expected finishing time. Finally we heard the starting gun above the clamor of friends finding each other and comparing training and breakfasts. We walked for several yards. Finally the clog of our competitors thinned out enough for us to run without tripping over each other's heels.

The course began by following the river side of Memorial Drive past the M.I.T. dorms.

The one-mile point was farther than I thought it would be. There was a water station, and there was Kim Valentine, a member of the Cambridge Sports Union, the group taking care of the technical side of the race, yelling out times. My mile was 9:30, better than the ten-minute pace I expected to be able to run.

Another water station had been set up by the Hotal Sonesta. I passed it up — I shouldn't need to take water more often than every mile at the stations. We crossed the little bridge, passed the MDC station, and ran over the dam. A short way down Storrow Drive we were diverted onto the Esplanade.

I passed the two-mile mark at 18:06. I ran a mile in 8:36! I thought, slow down, kid, you've got over four miles to go. At least the weather was good: cool, overcast, and breezy, although I felt cold each time I dribbled water down my shirt.

Runners started dropping out. I passed them saying, "Keep moving, keep it up."

The third mile passed, and I finished it at 27:09. We passed one of the two wheelchair runners and offered her trite but sincere encouragement. I wondered how they would get up the stairs to the Harvard Bridge. I decided that they would be carried up — that made the most sense.

The bridge loomed, and I hoped there wouldn't be a crush at the bottom of the stairs. I couldn't tell whether the crowd ahead of me was spectators or runners. I reached the stairs, the crowd parted, and I took the steps two at a time, the way I always do.

The fourth mile was on the bridge. I was sticking to a nine-minute pace. We ran down the sidewalk, and the narrow breakdown margin to the road was packed with spectators.

We turned onto Memorial Drive again, heading east. I knew there was a turnaround somewhere ahead. It was all the way down by Sloan.

I passed the fifth mile at just over 45 minutes, sure I could maintain that pace to the end. Running by Walker and the Great Court, I saw a few people I knew. I began to hurt. My legs were getting tired and my lungs were beginning to strain a little. Then, the finish appeared, the sign above the road fluttering deceptively close against the sky. I can speed up a little, I thought, or rather we thought, for everyone around me was speeding up.

I reached the finish and was directed to go through the left-hand chute and keep my place. At the end of the chute two men took down our numbers. Released, I found my sweatsuit and learned that my mother had gone back out onto the course to run in with my grandmother. I decided to follow my mother's example.

I found them by Baker, and we ran in side by side, all wearing shirts publicizing my mother's campaign. At the finish line photographers popped out to take our picture, and after my grandmother emerged from the finish chute, we were interviewed again. My mother kept talking about the amazing turnout for the race (2,300 runners), the growth of women's running since she started 15 years ago, and her campaign.

After my mother had assaulted every reporter present with her cute story of three generations of women in one race, I was allowed to leave.

I trotted back past Westgate and Tang. It hadn't mattered that we were women; what mattered was that we ran. I would go back to my dorm via *The Tech* office; anyone there would either be impressed that someone could run six and a quarter miles, or would be into sports and would understand why I was so impressed with my time, 55:20. Either way, I would feel like the conquering hero returning — note, hero. It's a non-sexist term.

**Fall Sports: "Breaking," "Grasping," "Smashing," "Snatching," "Drowning"**

The optimists among *The Tech*'s headline writers had plenty of work to do during the fall sports season . . .

"Shooters break two records." . . . "Volleyball grasps for the big one" . . . "Women's tennis smashes Mass. state champions" . . . "Booters go on the warpath" . . . "M.I.T. women fourth in the Head" . . . "Sailors snatch Schell, head for Atlantic.' . . . "Water polo drowns opposition" . . .

All the varsity records made good reading; here are some of the details:

*Water polo:* Going into a season-ending tournament at M.I.T., the team's record was eight wins, five losses — compared to a 5-8 record last year; when the splashing was over, M.I.T. ranked second only to Brown (1975 and 1976 New England champions) in the region. Then came the comeuppance — defeats to Yale and Southern Connecticut, and shattered dreams of a New England championship.

*Golf:* For the first time in history, the golf team qualified for the eastern championships and returned elated from Hamilton, N.Y., after placing in the middle of a 14-team field.

*Soccer:* Early in the season, Robert B. Host, '81, of *The Tech* said Head Soccer Coach Walter Alessi was worried: the team "might get overconfident" after defeating Brandeis, defending national champion. Maybe he was right: soon enough the season record had dropped to 5-5; but the final outcome was a 7-6 record, the first winning season since 1963. Coach Alessi noted that "the defense was generally outstanding. . . [but] if you can't score, you can't win."

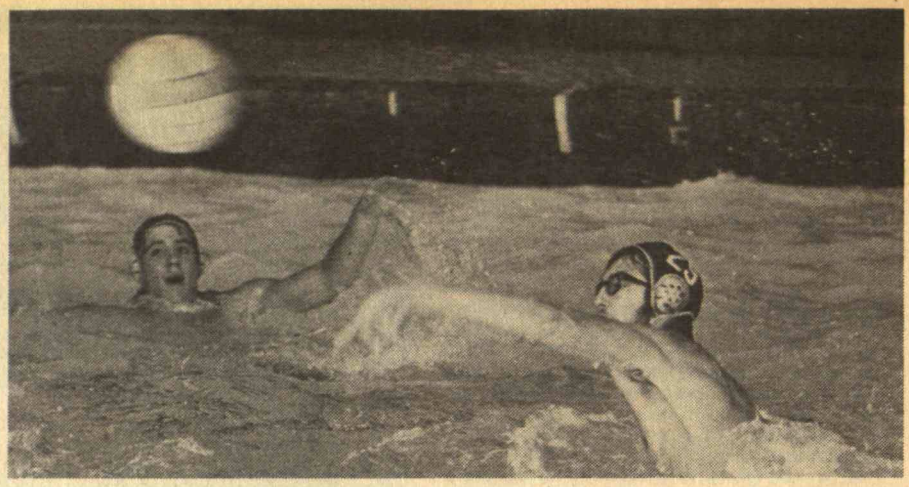
*Tennis:* Out of 46 schools at the New England Women's Collegiate Championships, M.I.T. finished 14th; then they came home and beat Boston State College, last year's Massachusetts champion.

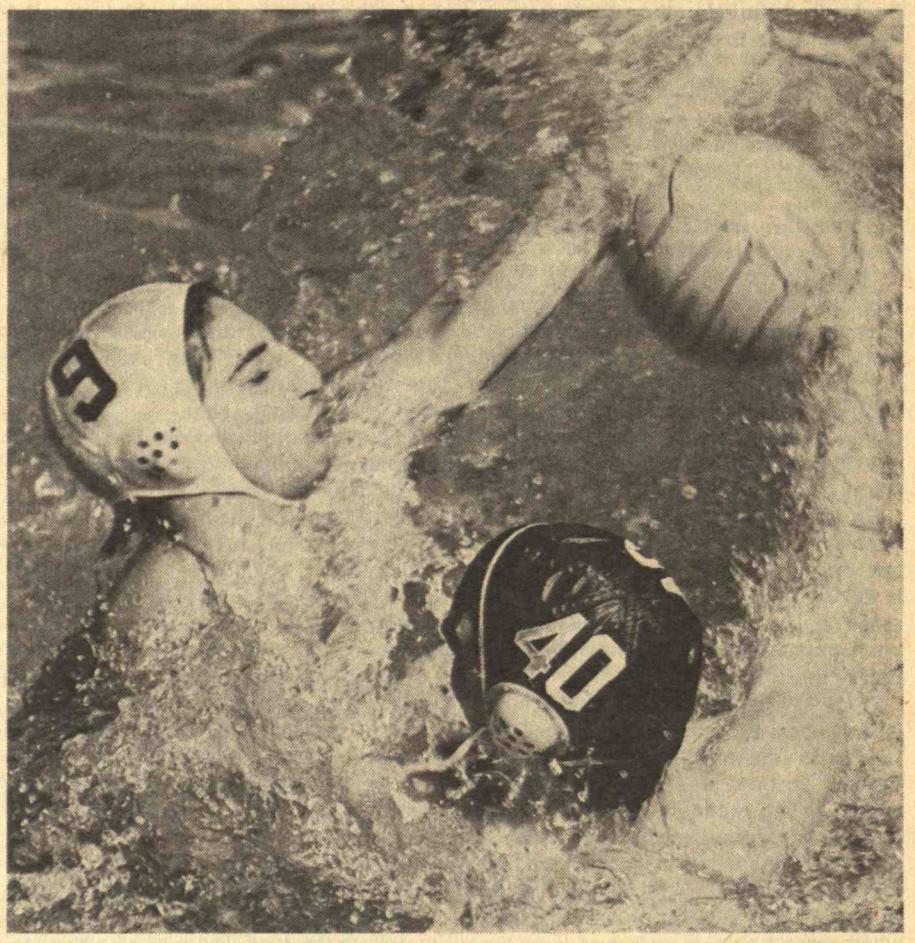
*Pistol:* Cheers for David Miller, '79 — a gold medal from the Pan-American Games in Mexico City in November for his part in the first-place finish of a three-man American Junior Team.

*Cross-Country:* It wasn't the best of all seasons, but the record is not so bad: fifth out of seven in the Greater Boston championships, 17th out of 37 in the New England championships, and eighth out of 26 at the IC4A meet in New York.

*Crew:* The women's crew was seeded 36th in a field of 40 for the Crew Head of the Charles Regatta, but they cruised home in fourth place, behind only Wisconsin, Vesper, and St. Catharine's (Canada), ahead of such rowing greats as Radcliffe, Mt. Holyoke, Cornell, and Pennsylvania. And Coach John Miller, '74, says the team is "nowhere near the level of conditioning we should reach by the spring racing season."

*Sailing:* Look at this list of trophies in the Sailing Pavilion from the fall campaign: the Jack Wood Trophy (men), the Captain's Cup (women), the Oberg Trophy (men), and the Schell Trophy (men), the latter being the most important regatta of the season.






**Water Polo: New Speed, New Stamina, New Timing, and "Fouling Is Part of the Game"**

No accident that there are remarkably good photographs of the varsity water polo fall season: Gordon R. Haff, '79 — his pictures have graced many of our pages — was Manager. And he had a good subject, for water polo had its best season since 1971, finishing third in New England and defeating Harvard for the first time in four years and Yale for the first time ever.

Water polo is a very special game — hard to play and hard to photograph. Here are some of Gordon Haff's explanations:

"In soccer a person instinctively has a 'feel' for how long it takes to reach the ball, how fast someone is moving, and what he needs to do to intercept an attacker. Not so in water polo. The participants are out of their native environment, and one has to develop a completely new sense of speed and timing.

"Another point: in other sports, a participant's entire body is visible, so fouls are rather obvious. In water polo, only a part of a person's body is above water. It is accepted practice that the referee 'doesn't see' anything which occurs under the surface. It is a sport in which fouling and being fouled are an accepted part of the game.

"While most active sports require a great deal of stamina, in water polo it's more so. You not only have to expend energy to get somewhere; you have to expend energy just to stay put — assuming, of course, that you don't want to sink to the bottom of the pool."

*Top: Sarah Caldwell, Artistic Director of the Opera Company of Boston and a member of the Council for the Arts at M.I.T., talks with Council Members Leo L. Beranek (left), President of television station WCVB, and Roy Lamson, M.I.T. Special Assistant to the President for the Arts, before an afternoon panel discussion; Dr. James R. Killian, Jr., '26 (left), receives the Eugene McDermott Award for "major contributions to the arts as a means of human fulfillment" from Luis A. Ferré, '24, Chairman of the Council.*

**M.I.T. Council for the Arts**

Words in an art gallery? An incongruity to most of us. But written words and visible images are separate concepts by tradition, not by logic, for each is a medium of communication and each should have an intimate relationship with the other.

That is the point of the Visible Language Workshop in the Department of Architecture, where Muriel Cooper, Design Director at the M.I.T. Press, helps students explore the visual sense of words. "We encourage students to find the great vitality of letter forms and express with them," she told members of the Council for the Arts at their annual meeting this fall. "We send kids out to study the impact of messages on the environment — we are manipulated by them, and we don't realize how much."

Council of the Arts members were given a morning program of such discussion, as well as a presentation of Renaissance music played on four Renaissance recorders by the M.I.T. Early Music Society, a film of a 140-foot-long outdoor kinetic sculpture called "Centerbeam," a discussion of music by Marcus Thompson, Professor of Music, a Dramashop presentation of a Chekhov play, "The Proposal," and other presentations.

At lunch, the Council's annual Eugene McDermott Award was presented for "major contributions to the arts as a means of human fulfillment." This year it was presented to Dr. James R. Killian, Jr., '26, Luis A. Ferré, '24, Chairman of the Council, cited Dr. Killian as "someone who has given M.I.T. a sense of the importance of art in life. We specially honor his continuing contributions, in the words of the Institute's founding charter, to the 'advancement, development and practical application of science in connection with the arts.' . . . No one has seen this connection more clearly than Jim Killian nor spoken more persuasively of an enlarged vision of education in which the sciences and the arts have much to say to one another."

From Dr. Killian's acceptance: "I can report the existential response of a septogenarian to what has been happening to our intellectual and aesthetic environment. It is wonderful to go loping about the Institute, through its buildings and about its

campus, and to encounter exciting examples of the visual arts. . . . [Art is] placed sometimes in unexpected places; and as I walk through the buildings, it is a delight to turn into a corridor or enter a commons room and there to find a piece of sculpture or a striking painting."

**20 Years of Revolutionary Physics**

Can it be 20 years ago that Professor Jerrold R. Zacharias wrote to then-President James R. Killian, Jr., '26, that he wanted to experiment with some motion pictures to help high school students learn physics?

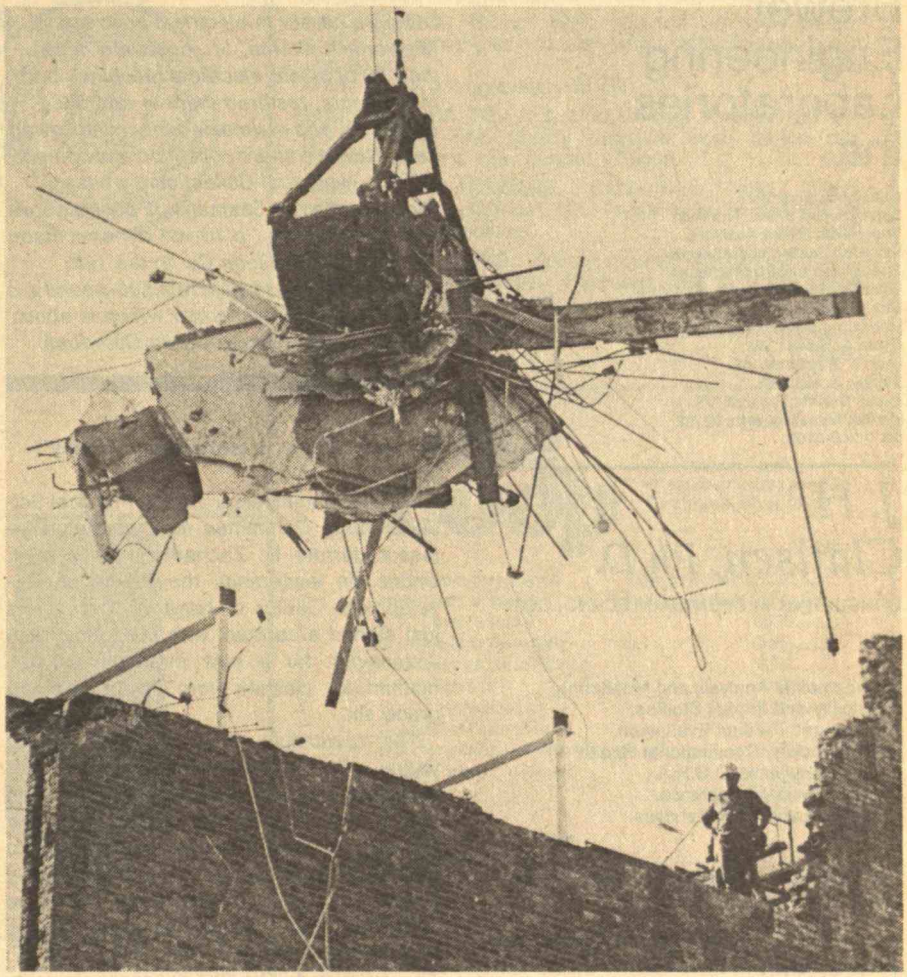
Indeed it is, and since then D. C. Heath and Co. has printed over one million copies of *Physics*, the high school physics program written by the Physical Science Study Committee (P.S.S.C.) which grew out of Professor Zacharias' conviction that physics could be given new life and meaning to young people. Francis S. Fox, President of D. C. Heath, thinks each copy may be used by four or five classes of students before it wears out; that means upward of 5 million students in the U.S. and Canada — and who knows how many overseas, using one of 500,000 copies of the translations into 17 different languages?

*Physics* has "revolutionised the teaching of physics throughout the world," Mr. Fox said at a small celebration of its 20th anniversary and millionth copy late last fall, and it's now "the standard against which all physics texts are measured." It's still going strong — a fifth edition is being planned, and through four editions in 20 years there have been no compromises, no embracing of fads and short-cuts. It's still "a demanding course," says Professor Uri Habersham of Boston University, who is now a principal editor.

**1,689 Pints in Eight Days**

In eight days early in November, students and staff flocked to the Sala de Puerto Rico in near-record numbers to give 1,689 pints of blood to the Red Cross. It's the largest response to one of the twice-a-year drives since 1974 — and it makes secure M.I.T.'s reputation as one of the largest sources of Red Cross blood on the East Coast.

With free kegs of beer to the top four dormitory and fraternity turn-outs, Sigma Phi Epsilon set the pace with 100 per cent participation. Delta Upsilon was second (97.2 per cent), Beta Theta Pi third (96.4 per cent), and Phi Mu Delta fourth (93.3 per cent, up 6 per cent from last year). The big improvement was in the dormitories, where Russian House participation was up 62 per cent; other winners were German House, Burton third floor, and McCormick fourth-west.



**The End of a Landmark**

*Our oldest readers will remember it as the home of Hood Rubber Co., the source of an inimitable perfume by which the wind direction could be determined long before one emerged from his dormitory into the gray cold of a Cambridge northeaster. If your generation is post-World-War-II, you'll remember the Hood Building as a rabbit warren of walls and doors presided over by Professor Charles S. Draper, '26. But last year the Draper Laboratory consolidated itself into a wondrous white building in Technology Square, and this fall the Metropolitan District Police installed parking meters on Memorial Drive. So the Hood Building, on Albany Street just off Massachusetts Avenue, fell victim, the land more valuable for parking than for the building it supported. (Photo: Calvin Campbell)*

*During a career in electrical contracting, Ellsworth A. Wente, Sr., collected more than 80 obsolete electrical machines and instruments, restored them to operating condition, and maintained them with loving care. Now the entire collection has come to M.I.T.'s Historical Collections, whose Director, Warren Seamans, is posed above with the smallest ( a 10-volt dynamo made by Carlisle and Finch Co. in the 19th century) and the largest (a 3,500-pound a-c General Electric generator which is about 50 years old). (Photo: Calvin Campbell)*

### Toward "Basic Quantitative Literacy"

On the 20th anniversary of the Physical Science Study Committee (*see above*), Professor Jerrold R. Zacharias is still at it. Under his leadership, the Education Development Center of Newton, Mass., has just signed a contract with Harcourt Brace Jovanovich for a new mathematics curriculum for classes from kindergarten to grade six.

The curriculum project follows several years' work on television programs designed to increase mathematics motivation and on tests appropriate to the elementary grades. The idea is to give students "basic quantitative literacy, in which they not only come to use their common sense but come to trust it," says Professor Zacharias, who is now retired from active teaching at M.I.T. The program will be "the successor to present school mathematics," and Professor Zacharias is confident that "a full battery of materials can be put together very quickly."

### Noche Mexicana in Guanajuato

For a weekend of M.I.T. fellowship in Mexico, reserve now for the 1978 Fiesta of the M.I.T. Club of Mexico, March 9 through 12.

It's the 30th annual running of a series which has brought the charm and traditions of Mexico to thousands of alumni from throughout the U.S. Now there's a new emphasis to attract Mexicans as well as those from north of the border to explore their land.

Accordingly, this year's Fiesta begins on board a bus in Mexico City on March 9, headed for three nights in Guanajuato, a colonial city 100 miles to the northwest. Then will follow a day trip to San Miguel Allende, a center of art and culture; the classic "callejoneada" (leisure stroll through the town center accompanied by musicians); and the traditional, gala "Noche Mexicana" party. An optional return to Mexico City by air on Sunday morning is available. The price is $240 U.S. per person.

For further information, write Joseph J. Martori, Director for Alumni Services of the Alumni Association at Room E19-438; or call William Collins, '65, at (905) 520-5807.

### Mares Career Development Chair

Friends and family of the late Joseph R. Mares, '24, have joined to fund a career development chair to honor Mr. Mares and perpetuate his life-long interest in the training of chemical engineers.

Mr. Mares joined Monsanto Co. as its first patent lawyer in 1929 and rose to become Vice President before 1954, when he formed his own consulting firm in Houston, Texas. The career development chair named in his honor will be awarded to young members of the chemical engineering faculty who want to pursue special research or teaching projects.

### Architecture Department Begins a Survey of its Alumni

Architecture alumni can expect a phone call at home during January. The architecture department is initiating the first stage of a six-phase project to record information on graduates' careers spanning 20 years. "There is an increasing need to respond to repeated requests for information," says Sophia Sieczkowski, Assistant to the Head of the Department of Architecture.

The project began by sorting lists of graduates by graduation year to eliminate persons with multiple degrees and to identify active graduates. During phase two, alumni are asked their current home and work address, job title, and if they receive and read *Plan,* the department's newsletter.

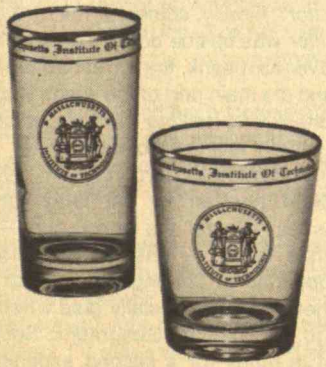
"We anticipate making about 3,000 telephone calls using the WATS line," says Ms. Sieczkowski.

Eventually, a comprehensive questionnaire about graduates' activities will be included in *Plan,* the data received will be recorded in a way that will be useful to the architecture department and the alumni office, and the results of the survey will be summarized and reported in a subsequent issue of *Plan.*

# M.I.T. INSIGNIA

*A GOOD WAY TO REMEMBER*





**M.I.T. CHAIR.** A traditional favorite made of selected northern hardwoods and finished in satiny black with gold trim and gold M.I.T. crest. In all black or black with cherry arms. each **85.00**

**M.I.T. CHAIR CUSHION.** Tough Duraleather cushion in deep red with grey piping and 2" thick foam filling. **13.00**

**M.I.T. PLAQUE.** Bronze seal mounted on solid walnut shield or rectangle. Comes with self-adhering brass nameplate. **27.95**
For two lines of engraving, add 7.00

**M.I.T. INSIGNIA TIE.** A distinctive way to show off the M.I.T. shield. Fine quality polyester with repeat pattern on maroon or navy ground. 4" wide. **6.95**

**INSIGNIA GLASSWARE.** Hand-blown with silvery M.I.T. seal and platinum rim. Available in Hi-ball, Single or Double Old Fashioned. each **2.50**

**DIRECTOR'S CHAIR.** Sturdy folding hardwood frame in natural or black finish. Seat and back in heavy white cotton duck with 3-color M.I.T. seal. **33.95**

**DIRECTOR'S CHAIR** with walnut finished hardwood frame. **41.90**

1977

**the Coop**

M.I.T. Student Center
84 Massachusetts Avenue
Cambridge, Mass. 02139

| Quan. | | | TOTAL |
|---|---|---|---|
| ____ | M.I.T. Chair, cherry arms | Express Collect 85.00 | ____ |
| ____ | M.I.T. Chair, all black | Express Collect 75.00 | ____ |
| ____ | M.I.T. Chair Cushion | 13.00 | ____ |
| ____ | M.I.T. Insignia Tie in navy | 6.95 | ____ |
| ____ | M.I.T. Insignia Tie in maroon | 6.95 | ____ |
| ____ | Hi-ball Glasses | 2.50 | ____ |
| ____ | Single Old Fashioned | 2.50 | ____ |
| ____ | Double Old Fashioned | 2.50 | ____ |
| ____ | Director's Chair ( ) natural, ( ) black | 33.95 | ____ |
| ____ | Director's Chair in walnut | 41.90 | ____ |
| ____ | Plaque | 27.95 | ____ |
| ____ | Engraving | 7.00 | ____ |
| | ( ) Shield, ( ) Rectangle | | |

Name to be Engraved _____
Class of _____

Please ship to: _____
Street _____ City _____
State _____ Zip _____
Ordered by: _____
Street _____ City _____
State _____ Zip _____
COOP # _____

☐ CHARGE MY ACCOUNT ☐ OR I ENCLOSE REMITTANCE

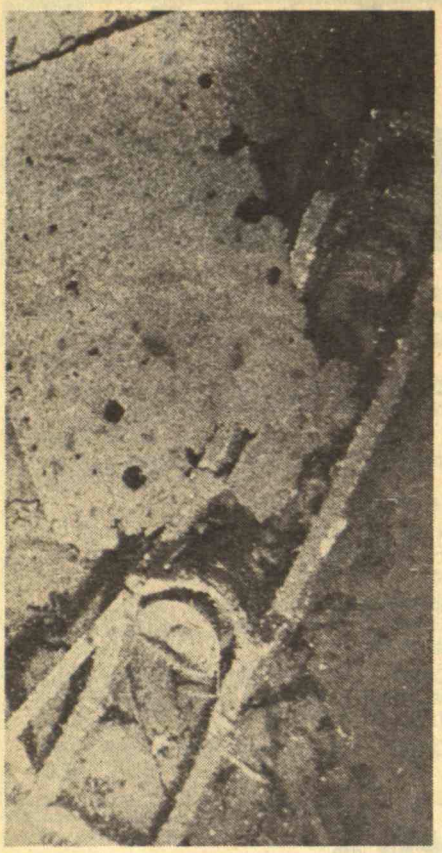
*Mass. Residents: Add 5% sales tax (except ties).*
*Out-of-state Residents: No tax except when delivered in Mass.*

SHIPPING AND HANDLING (Continental U.S.A.)

| | | N.E. States | East of Miss. | West of Miss. |
|---|---|---|---|---|
| Director's Chair, Glassware | (per order) | 2.50 | 3.50 | 4.50 |
| Personalized Plaque | (per order) | 1.25 | 1.75 | 2.25 |
| M.I.T. Chair Cushion & Tie | (per order) | 1.00 | 1.25 | 1.50 |

M.I.T. Chairs: Freight charges collected upon delivery.
Please allow approximately 4 weeks for delivery.

**ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE**



*Back from the* Monitor *after four years off Cape Hatteras. Remember that camera lost when Professor Harold E. Edgerton, Sc.D. '31, helped find and identify the remains of the* Monitor *in 1973? The camera is at M.I.T. now, and Professor Edgerton admits he lost a five-cent bet. The camera is finished. The Alcoa Seaprobe photograph (1974) shows the camera trapped under a rusted steel plate in the* Monitor's *bottom. Both the camera/strobe and the plate were brought to the surface during the N.O.A.A./Harbor Branch Foundation Expedition in 1977, and Professor Edgerton was there to receive his encrusted prize.*

**The Camera Raised From the *Monitor* Wreck**

*by Harold E. Edgerton, Sc.D. '31*

This is the tale of an underwater camera with a strobe light and pinger, which was caught in the *Monitor* wreck in 1973 *(see February, 1975, p. 8),* brought to the surface twice and is now exhibited in the M.I.T. Strobe Lab Museum.

When the camera was lowered from Duke University's Marine Laboratory's research vessel *Eastward,* some 16 miles off Cape Hatteras, it recorded a badly rusted iron ship, but there wasn't enough information to make an identification. Subsequent TV coverage and later photographs identified this wreck as the long lost *Monitor.*

The famous Union vessel had sunk under tow in 1862; many people had searched for it without success. Our 1973 effort, headed by John Newton of the Duke University Marine Lab, had several advantages, including a team of talented people and considerable technical equipment, such as side-scan sonar, for navigation and exploration. We had started off with great hopes, but as mile after mile, hour after hour passed slowly, a featureless sea bottom revealing no wrecks at all, many were feeling down. They say that several hundreds of wrecks are to be found in this area. But our experience was telling us that there is also a great deal of ocean.

Fred Kelly of Duke University took the prize for being alert when the decisive sonar contact was made. A buoy had gone into the water immediately, and we started a series of experiments with underwater photography and television to identify the contact. It was on the second lowering that the camera assembly dropped into a hole in the bottom of the inverted *Monitor,* catching on some of the structure. A surge of the *Eastward* tightened the quarter-inch steel cable. Something had to give, and it was the cable — our only link with the camera; the cable parted at the winch and fell into the wreck.

Next an underwater television camera was gingerly lowered; we did not want to lose it, too. That did the trick. I remember so clearly the moment that we recognized the turret. It seemed to be half concealed by the ship. How could the turret be underneath the *Monitor?* Finally, someone realized that the *Monitor* was upside down! The ship had turned over as it sank, the turret had broken loose, and the main part of the wreck landed on the stern — breaking the armour plate and eventually falling across the turret.

When I returned to Cambridge in 1973, I had added another to the long list of cameras lost all over the world. And — as my friends know — one of my favorite preoccupations is figuring out how to retrieve them. I was especially glad when an appeal to the National Geographic Society resulted in funds for a second expedition: the U.S. Navy arranged for the Alcoa Sea-

probe to stop by on its way north from Florida in 1974. The result of this effort was a foldout photomontage of the entire *Monitor* wreck, published in the January 1975 issue of the *National Geographic* ("How We Found The *Monitor*" by John Newton). The position of the camera is clearly shown in these photographs, under a bottom plate that is loose since the rivets have all rusted away. But the dangers of putting any mechanism into the wreck led Seaprobe to abandon any effort to retrieve the camera.

In 1975, I proposed a simple grapnel pick-up system which had a TV camera to observe the action. An operator on the surface would know what to do to get the hook into the camera framework. But this idea was frowned upon by several archaeologists, who worried that damage could be caused by the camera frame and cable as it was lifted from the wreck. I still think it was a good idea and I hope to try it some other time on some other project.

Since 1973 I've been above the *Monitor* wreck six times. In 1974, seeking sideview photographs to supplement the vertical pictures made so beautifully by Alcoa Seaprobe, then aboard the U.S.C.G. vessel *Chilula* with Dr. Lloyd Breslau, '57, of the Coast Guard's Research and Development Center, Groton, Conn. then we were defeated by weather and sea conditions. Two weeks later I was back aboard the *R/V Beveridge* with John Newton, but we had some archaeological restrictions, I had some technical problems with my underwater TV and strobe camera, we had bad weather, and time eventually ran out on us. My fifth attempt came last spring (1977) aboard the University of Delaware's *R/V Henlopen* with Dr. Robert Sheridan, when some excellent side views of the armour plate were made but we missed the turret.

Meanwhile, the site of the *Monitor* has been designated the nation's first Marine Sanctuary by Frederick Dent, Secretary of Commerce, in 1975; the National Oceanic and Atmospheric Administration's interest in future explorations was assured.

So it was N.O.A.A., with support from the Harbor Branch Foundation, that laid out an ambitious program involving two ships and two submarines for 1977. Aside from stereo photography (both vertical and horizontal), the program called for divers to use cameras to record objects inside the wreck and to recover a loose steel bottomplate and recover Duke's camera/strobe/pinger assembly.

This is what I had been looking forward to since 1973. It was my hope that the camera would yield films of use. At least I could see what four years of ocean immersion had done.

The problem went smoothly, except for weather problems and a few technical difficulties. Before my arrival, a side-scan sonar survey was made of the entire area, excellent TV tapes were obtained of the entire wreck, vertical and horizontal stereo photographs were made, and divers began to take photographs with hand-held cameras of spots that the submarine's cameras could not reach — inside the wreck, for example.

Finally the time came for the last — and for me the most important — part of the program. Diver Richard Roesch was briefed carefully on his important tasks. His equipment included ropes and air bags with which to lift the items; a minature submarine was stationed to observe his work.

Up came the iron plate attached to its air bag by special push-through clamps in the rusted rivet holes. Next was the camera assembly. From the submarine pilot, we heard that the diver had inflated the air bag, and we all eagerly watched the surface for the arrival of the bright-yellow doughnut it was attached to. There it was! But suddenly it belched a large quantity of air and spray and promptly sank. We immediately gave the sub's pilot a compass heading to where we thought the camera had gone down, and soon word came back that the equipment had been located and picked up by the submarine's articulated arm.

Everyone held their breath as the camera assembly was carefully lifted over the side of the ship. Finally we relaxed; the gear was on deck, and we could see what four years of seawater exposure had accomplished. A quick glance showed me that the camera's end plate, with its glass port, was missing. The entire inside of the camera was exposed. A white slimy material seemed to fill the entire front end. The back plate was still in place with the wires attached.

I should admit that I made and lost a five-cent bet with John Newton that the camera and strobe would be ready to go, needing only new batteries and fresh film. The payoff was certain after a ten-second look at what came out of the ocean. The pressure cases on the camera and strobe were made of stainless steel and capable of 17,000 ft. depths. However, crevice corrosion according to Professor Herbert Uhlig (M.I.T.'s Materials Science and Engineering Center) was our undoing.

I often joke about my cameras, noting that I stamp my name and address on the cases so that finders will return them to me. So far, the only returned camera from the ocean is that one from the *Monitor* wreck, and it was not marked.

*D. Reid Weedon, '41, wins the Dalton Bowl for "sustained service . . . in enhancing M.I.T.'s independence." The surprise was complete, and the smile is genuine as Mr. Weedon receives the award from Howard W. Johnson (left), Chairman of the Corporation, during the 1977 annual meeting of the Corporation's Development Committee in Cambridge late last fall. Marshall B. Dalton, '15, was first Chairman of the Development Committee, having served as Chairman of a major capital fund drive — the Committee on Financing Development — 25 years ago.*

### Honoring Resource-Building: The Dalton Bowl to Weedon

Members of the Development Committee of the Corporation are the strategists of M.I.T.'s future financial resources, the principal support for the Corporation itself and its Resource Development staff in fund-raising and development.

And the most supportive of the Corporation Development Committee is now designated each year for the Dalton Bowl, honoring the late Marshall B. Dalton, '15, who is described as one of the most active and respected alumni leaders in M.I.T. history.

For 1977 the Dalton Bowl belongs to D. Reid Weedon, '41, Senior Vice President of Arthur D. Little, Inc., a long-time volunteer worker for the Institute through the Alumni Association and the Corporation. The presentation, said Howard W. Johnson, Chairman of the Corporation, recognizes Mr. Weedon's "conspicuous and sustained service in enhancing M.I.T.'s financial independence."

Mr. Weedon is Area Chairman for Boston for the current $225-million Leadership Campaign; he's been a member of the Corporation since 1970 and of the Development Committee since 1965. But his principal service to M.I.T. has been through the Alumni Association: he was President in 1961-62; he was principal architect of the Long-Range Planning Committee in the 1960s and Chairman of the Alumni Fund Board from 1963 to 1965; and he has held countless assignments for his Class and for the Association.

The first Dalton Bowl was given to Mr. Dalton himself shortly before his death in 1975. The second presentation was made quietly to Cecil H. Green, '23, a year ago; the award honored Dr. Green and his wife, Ida, for the active interest in the Institute which has yielded buildings, laboratories, professorships, and numerous fellowships and scholarships.

### From Physics to the Dean's Office

Alan J. Lazarus, '53, who taught physics at M.I.T. for ten years beginning in 1959 and during that period won the Baker Award for Outstanding Undergraduate Teaching, has cemented his interest in undergraduate education: he is now Associate Dean for Student Affairs and Director of the Office of Freshman Advising.

He succeeds Peter Buttner, '61, who's now studying for a master's degree from the Sloan School of Management.

Dr. Lazarus will continue half-time work in the Center for Space Research. As a member of the physics faculty he participated in teaching experiments ranging from seminars to free learning environments.

### Wootton Joins the Corporation

Katrina M. Wootton, '77, a graduate student in the School of Organization and Management at Yale University, is now a member of the M.I.T. Corporation, serving the last two years of the term of David R. Wilson, '73, who resigned to enter the Graduate School.

Ms. Wootton occupies one of five Corporation memberships reserved for members of recently-graduated classes; they are nominated by vote among members of those classes. Ms. Wootton was runner-up to Vincent S. Castellano, S.M. '77, in the ballotting last spring.

### Chester L. Dawes 1887-1977

Chester L. Dawes, '09, the Secretary of his Class at M.I.T. for the past 25 years and recently a member of the Alumni Council, died of a heart attack on November 4; he was 90.

Mr. Dawes was Associate Professor Emeritus at Harvard, having retired in 1953 from a teaching career in the Department of Electrical Engineering that began in 1911. He was known for his invention of the peak voltmeter and the high-heat mica plate, and was the author of several electrical engineering textbooks.

Mr. Dawes was Vice President of the American Institute of Electrical Engineers from 1938 to 1940 and was a past chairman of the Boston and New England Divisions of that professional society.

### Irving W. Wilson, 1890-1977

Irving W. Wilson, '11, former Chairman of the Board of Aluminum Co. of America who

was the eldest member of the M.I.T. Corporation, died on October 16 in Pittsburgh following a short illness. He was 87.

Mr. Wilson joined Alcoa immediately upon graduating from M.I.T., having attracted the attention of the President of Alcoa to his undergraduate thesis on aluminum smelting. Soon thereafter, transferred to Alcoa's New Kensington, Penn., works, Mr. Wilson acquired the nickname "Chief Wilson," after a fading Pittsburgh Pirate outfielder. It stuck — and became ever more appropriate as Mr. Wilson rose to become General Superintendent of Smelters (1921), Vice President in Charge of Operations (1931), Senior Vice President (1949), and President (1951).

First elected to the M.I.T. Corporation in 1943 after nomination by the alumni, Mr. Wilson became a Life Member in 1951. The Irving W. Wilson Fund for Management Education and Research was established by the Alcoa Foundation in the Sloan School of Management in 1970 — a tribute to Mr. Wilson's career and his interest in M.I.T.

**Peter S. Haase, 1956-1977**

Peter S. Haase, '76, died on October 4 in Palo Alto, Calif., where he was employed in a Course VI-A work assignment at the Electronics Research Laboratory of Hewlett-Packard Co. Mr. Haase, a teaching assistant in the Department of Electrical Engineering and Computer Science, would have completed studies for his master's degree during the spring term, working with Professor Francis F. Lee.

**Marc-Emile Deguire, 1958-1977**

A fall from the 16th floor of the Green Building brought death to Marc-Emile Deguire, '79, on October 16. Mr. Deguire withdrew from M.I.T. for one year after completing the fall term in 1975; he reentered in the spring term in 1977.

**Arthur C. Hardy, 1895-1977: Pioneer in Photography, Optics**

Arthur C. Hardy, Professor of Optics and Photography, Emeritus, who served on the faculty for more than 30 years after coming to M.I.T. from the University of California in 1917, died at his home on October 31 following a brief illness. He was 81.

Professor Hardy was credited with inventing his spectrophotometer, a device associated with sound recording on film for motion pictures, and he held a number of patents in the field of light measurement and color reproduction. He taught courses in optics and photography in the Department of Physics from 1922, when he was first appointed as Assistant Professor, until he retired in 1961.

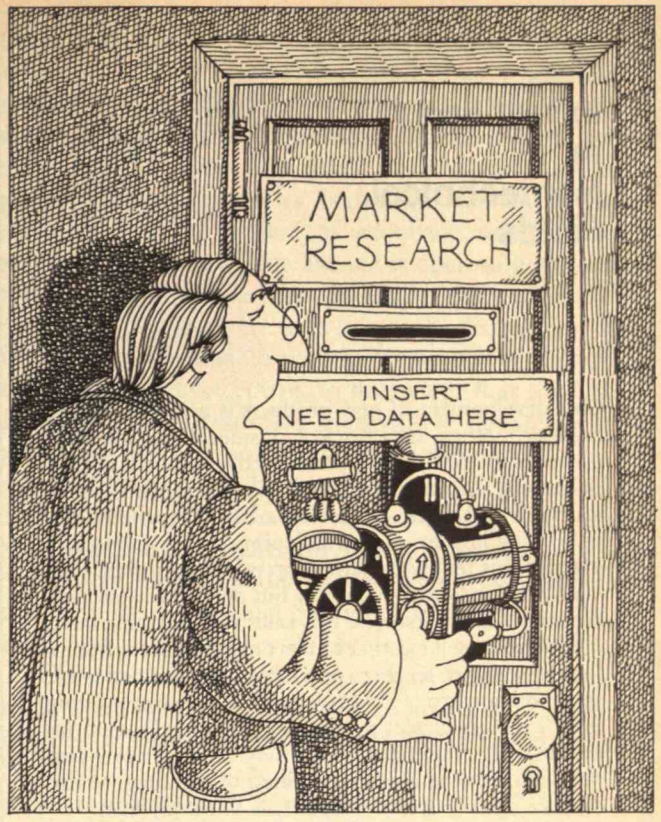
In addition to honorary doctorates from St. Lawrence University and the University of California (from which he held two academic degrees), Dr. Hardy held four major professional awards: the Longstreth Medal from the Franklin Institute, the Frederic Ives Medal of the Optical Society of America, the Progress Medal of the Society of Motion Picture and Television Engineers, and the Pioneer Award of the National Association of Manufacturers. He was President of the Optical Society of America from 1935 to 1937 and its Secretary from 1939 to 1957.

**Deceased**

*Phelps N. Swett,* '07; July 7, 1977; 49 South St., Middlebury, Vt.
*Wilfred E. Booth,* '08; September 19, 1977; 11 Bentwood St., Foxboro, Mass.
*Chester L. Dawes,* '09; November 5, 1977; 74 Wedgemere Ave., Winchester, Mass.
*Robert C. Glancy,* '09; April 20, 1977; 937 Stoneybrook Dr., Springfield, Penn.
*Arthur L. Shaw,* '09; October 20, 1977; 290 Central St., Auburndale, Mass.
*Joseph P. Maxfield,* '10; March 24, 1977; 705 Elder St., Escondido, Calif.
*Ormond R. Bean, Sr.,* '11; February 14, 1975; 460 Second St., Lake Oswego, Ore.
*William W. Goodhue,* '11; November 7, 1977; 13 Herrick St., Winchester, Mass.
*Richard H. Gould,* '11; October 21, 1977; 234 Hollywood Ave., Douglaston, N.Y.
*Irving W. Wilson,* '11; October 16, 1977; 1201 Murrayhill Ave., Pittsburgh, Penn.
*William L. Collins,* '12; October 10, 1977; 212 Main St., Hornell, N.Y.
*Harold A. Robinson,* '12; May, 1967; Trinity Presbyterian Church, 3003 Howell Mill Rd., Atlanta, Ga.
*Allison Butts,* '13; June 30, 1977; Lehigh Manor, Hanover Ave. at Wahneta, Allentown, Penn.
*Lloyd A. Hechinger,* '13; October 27, 1977; 85 Orchard St., Jamaica Plain, Mass.
*David V. Nason,* '13; April 19, 1977; 7031 North Belmont Ln., Milwaukee, Wis.
*Harold J. Coleman,* '14; December, 1976; 3518 Rosewell Rd., N.W., Apt. B-1, Atlanta, Ga.
*Ernest W. Mann,* '14; September 19, 1977; 28 Glen Rd., Granby, Conn.
*John R. Leighton,* '16; August 17, 1977; 100 Winslow St., Everett, Mass.
*John W. Stafford,* '16; August 13, 1977; 225 Wearimus Rd., Hohokus, N.J.
*William W. Eaton,* '17; June 1, 1977; 2619 Wilshire Blvd., Los Angeles, Calif.
*Arthur C. Hardy,* '18; October 31, 1977; 15 Kenilworth Rd., Wellesley, Mass.
*Grover C. Slator,* '18; July 26, 1976; 1209 San Jacinto Bldg., Houston, Tex.
*Ellsworth G. D. Paterson,* '19; September 8, 1977; 27 Interlaken Dr., Eastchester, N.Y.
*Oliver L. Bardes,* '21; October 13, 1977; 2627 Grandin Rd., Cincinnati, Ohio
*Louis L. Lesser,* '21; September 29, 1977; 4851 N. E. 45th, Seattle, Wash.
*Marshall G. Munce,* '21; October 15, 1977; 140 Rathton Rd., York, Penn.
*William M. Stratford,* '21; February, 1977; P.O. Box 546, Rancho Santa Fe, Calif.
*Robert M. McCullan,* '22; January 28, 1977; P.O. Box 246, East Dennis, Mass.
*Kenneth G. Merriam,* '22; October 17, 1977;

56 Havelock Rd., Worcester, Mass.
*Thomas H. Swisher,* '22; February 28, 1977; 1065 Questa Dr., Mountain View, Calif.
*Per K. Frolich,* '23; June 10, 1977; 1160 Wychwood Rd., Westfield, N.J.
*Samuel M. Hamill, Jr.,* '23; October 14, 1977; 811 Princeton Dr., Terrace Park, Ohio
*Edward J. Healy,* '23; September 9, 1977; 633 Black Rock Rd., Bryn Mawr, Penn.
*L. Melvin Nelson, Jr.,* '23; June 14, 1977; 1500 Hinman St., Evanston, Ill.
*Henry Y. Satterlee,* '23; September 29, 1977; 3449 Honolulu Ave., La Crescenta, Calif.
*Herrick O. Tappan,* '23; October 20, 1977; 2 Meadowbrook Rd., Weston, Mass.
*Maurice T. Crowell,* '24; October 7, 1977; 2301 Acacia W., Milwaukee, Wis.
*Lloyd Gensel,* '24; April, 1977; 915 Dallas Rd., Apt. 11, Marietta, Ga.
*Elizabeth F. Aub,* '25; August 3, 1977; 235 Prospect St., Belmont, Mass.
*Clifford C. Duell,* '25; September 25, 1977; 611 Westmont Dr., Fayetteville, N.C.
*James S. Moon,* '26; October 26, 1977; Lost Lake Woods Club, Lincoln, Mich.
*Eugene P. Nowlen,* '26; September 27, 1977; 522 Allview Terr., Laguna Beach, Calif.
*Spence W. Perry,* '26; September 24, 1970; Iroquois, Ontario, Canada
*Gordon F. Tracy,* '26; June 16, 1977; 153 Strathallan Blvd., Toronto, Ontario, Canada
*Benjamin L. Levinson,* '27; 1962
*R. Moen Smith,* '27; September 29, 1977; P.O. Box 1131, Christiansted, Saint Croix, Virgin Islands
*Joseph Wurtzel,* '27; September 21, 1977; 166 High St., Perth Amboy, N.J.
*Raymond C. Binder,* '30; September 18, 1977; 2711 Manning Ave., Los Angeles, Calif.
*William W. Driscoll,* '30; August 28, 1977; 143 Beacon St., Framingham, Mass.
*John Lovejoy,* '30; June 8, 1976; 3663 Grand Ave., Des Moines, Iowa
*Jack R. Kalman,* '31; July 2, 1977; 239 Crest Mont, Norman, Okla.
*William P. Cantono,* '32; June 28, 1977; 13 W. 84th St., Harvey Cedars, N.J.
*Theodore A. Chadwick,* '32; October 1, 1977; 30 Mesa Rd., Bolinas, Calif.
*Theodore J. Jones,* '32; July 29, 1977; 989 Campbellton Dr., North Augusta, S.C.
*Martin T. Meyer,* '32; October 8, 1977; 7600 Spring Ave., Melrose Park, Philadelphia, Penn.
*William H. Brothwell,* '33; March 18, 1977; 492 Prospect St., Torrington, Conn.
*Gene Cary,* '33; October 11, 1977; 540 Fulton St., Aurora, Colo.
*George F. Hollingsworth,* '33; 1965
*Peter A. Sorrentino,* '33; March 30, 1977; 59 Overlook Rd., Marblehead, Mass.
*Walter H. Sherry,* '37; October 15, 1977; 1160 Main St., Buffalo, N.Y.
*Henry C. Thayer,* '38; October, 1977; 3577 E. Leisure World, Silver Spring, Md.
*Archer S. Thompson,* '38; August 11, 1977; 506 Crestline Dr., Rolling Hills, Pittsburgh, Penn.
*Charles E. MacKinnon,* '39; July 10, 1977; 5202 Piping Rock, Houston, Tex.
*Lawrence D. Phillips,* '40; 1974
*Edwin Anisz,* '42; October 26, 1977
*Thomas H. Derby, Jr.,* '43; September 9, 1977; 707 Clyde Cir., Bryn Mawr, Penn.
*John H. Moss,* '43; July 22, 1977; 1034 Lampeter Rd., Lancaster, Penn.
*Kenneth W. Joseph,* '44; October 30, 1977; 605 High St., Walpole, Mass.
*Robert D. Remington,* '44; October, 1976; 603 10th Ave., South, Nampa, Idaho
*Ernest P. Miklau,* '48; December, 1975; 209 Green Hill Dr., Hagerstown, Md.
*James B. Morris, Jr.,* '48; 1973; Fawn Hill Farm, R.F.D. #1 Norton Rd., Frankfort, N.Y.
*Arthur R. Havener, Jr.,* '49; December, 1976; 189 Plain Rd., Wayland, Mass.
*J. M. Carney,* '50; June 12, 1977; P.O. Box 295; Gig Harbor, Wash.
*Charles W. Sorenson,* '52; April, 1977; 2252 Nelson Dr., Schenectady, N.Y.
*Elmo J. Pacini,* '53; October 30, 1977; 77 Clifford Rd., Sudbury, Mass.
*Emanuel Schoenberg,* '53; August, 1977; 4480-1 State Rte. 43, Kent, Ohio
*Paul L. Datt,* '55; December, 1976
*Charles E. Wernlein, Jr.,* '58; October 12, 1977; 655 E. 230th St., Bronx, N.Y.
*Daniel Goldenberg,* '59; September 26, 1977; 31 Irving St., Apt. 1-1, Watertown, Mass.
*Robert Blanchard,* '73; October 8, 1977; Visieu Petit, 01260 Champagne En Val, France
*Ralph T. Von Hagen,* '73; September 17, 1977; 251 Lovely St., Avon, Conn.

sales is interested in making sales, not accepting new products




Illustrations: Cameron Gerlach

market research can only accept need data

into contact with innovative users only a small proportion of the time. And when they *do* make such contacts, these units are inappropriately staffed and motivated to make much use of the information which may be available about user-developed products.

The dominant workload of technical services is typically field set-up, debugging, and servicing of existing products. Although minor product modifications are sometimes made by such groups for high-volume customers, the goal in general is to keep the customers happy with the existing products. If, in the course of their work — often performed on customer sites — technical service personnel should be offered information on user home-builts ("Why don't you people start building this? We're sick of making them in our shops."), they are not in a good position to take advantage of it because:

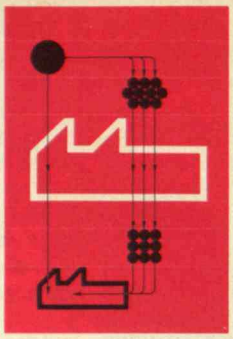
☐ Technical services is typically not staffed with people able to understand and make a good case for the commercial potential of a user-developed product; and

☐ Technical services typically has no incentive to gather such information or make such a case.

The typical sales force is set up to *output* information on existing products. It is true that sales people spend much of their time at customer sites, and so they ought to be in good positions to return information to their employers on promising user-developed products; but sales departments are typically not staffed with people able to do this job, and the typical commission and incentive schemes operating on them reward only sales of existing products. As a result, sales people have not only no incentive to accurately report on conversations regarding user developments which might have potential as commercial products; they have an incentive to deflect any such conversations towards the question, "What can I sell you of my present products?"

Finally, consider how the conventionally structured marketing research group would deal with data on user-developed products. Marketing research typically collects and analyzes data on user needs and then attempts to *generate* responsive new product concepts. "Have you any interesting new home-builts we should study?" is an alien question in such a setting. Indeed, any information on such home-builts which users, sales or technical service happens to bring to a conventionally oriented marketing research group's attention would probably be considered only as data on a user need, not as data on both a need *and* a potentially responsive solution. For example, if information comes to marketing research regarding a user prototype which functions better on some dimension than the product manufacturer's existing offering, need analysis methodologies such as multidimensional scaling would probably be invoked; these would ignore how the precision was obtained — the solution data in the user design — noting only that it was needed.

## User Innovation in Nontechnical Fields



User development of new products is not restricted to high-technology industries. Consider how the phenomenon occurs — and is managed — in the textbook publishing industry. Textbooks are almost invariably written by teachers — one class of users — and not by publishing houses — manufacturers. Many publishers manage this reality by setting up two sales forces. One deals with customers who buy but don't write, such as libraries and bookstores; this sales staff is trained and motivated to sell existing books only. The second sales force deals with teachers only, and is trained, selected, and motivated to (1) induce teachers to adopt existing texts for their classes as appropriate and (2) seek out promising manuscripts which may be under preparation. The type of incentive offered to salesmen to undertake this input *and* output role varies by firm.

Different groups often have different use-relationships to the same product. For example, while teachers use textbooks as teaching tools, students use them as learning tools. The manufacturer's problem in such instances is not to identify "the" user; nor is it often possible to do so. The problem is to identify the one or more categories in which innovative users are found so that the search for new products may be properly focussed. — *E. A. von H.*

And even if the conventional market research group included the user-solution data in its specification of a new product need, the conventionally organized research and development group receiving such a specification would tend to look at the data on a user's solution with a "not invented here" prejudice.

For these many reasons, the conventional interface which product manufacturers present to their customers offers multiple barriers to the perception and use of information on user-developed products.

### Interface Groups for Innovative Users

How should the market interface be modified in an environment in which user-developed home-builts are an important source of new products for the first-to-market manufacturer? The structure in the chart on page 33 suggests an answer to this question, based on our evidence that product users with a history of product innovation can be identified and separated from the mass of routine product users. For example, in our study of semiconductor process equipment innovations we found that all innovative users were among the top 25 per cent of all users in terms of their volume of semiconductor shipments at the time of the innovations. Accordingly, we propose separating innovative from routine product users and assigning to innovative users special sales and technical service sections whose organization, incentives, and staffing are appropriate for attracting and processing information on user-developed products.

It is true that some of the extra attention we propose paying to innovative users will be costly. But there will be compensating payback to manufacturers in the form of new products built upon research, development, and field testing performed by a user instead of by the manufacturer, the manufacturer thus saving much of the usual cost of these activities.

For innovative users, technical services should be expanded. Several types of activity — field-proven but not yet generally adopted — could be added by product manufacturers in industries characterized by user-dominated innovation. Among these:

☐ *User groups.* Commonly found in the computer software area and occasionally elsewhere, user groups are a mechanism by which users may exchange ideas and information on innovations they have developed. The cost to a manufacturer of sponsoring such a group is low, usually taking the form of providing a collection point for such information and disseminating it to members through newsletters and occasional meetings. The benefits in terms of access to the user-generated information is sometimes significant.

☐ *Applications laboratories.* In many industries, users are commonly invited to propose to manufacturers' applications laboratories their concepts for new applications for existing products. The manufacturer through the applications laboratory provides free or low-cost research and development help in working out the application. The user gains an effective new process while the manufacturer learns about the need and — often — is shown a user solution which can be developed into a salable new variation on existing products.

☐ *Custom product groups.* In industries where standard products prove to have usually started as custom products, it is often advantageous for a first-to-market manufacturer to offer good, fast, flexible help to that subset of users whose special needs have previously proved to foreshadow general demand. A good custom products group will induce such users to bring their developments to the sponsoring manufacturer.

A special sales force experienced in the technologies and problems of innovative users should be established to serve those users. As the staff of this sales force gradually prove their competence to the user firms, they will gradually obtain access to user-developed products which the user might wish to have built by an outside supplier, and they will have opportunities to bid on custom products with interesting commercial potential. Such a strategy is well established in some fields today.

Technical service and sales personnel assigned to a manufacturer's innovative users must work under compensation schemes which reward the sale of existing products, the sale of custom products, and information-gathering on user-developed products. Clearly, not all

user prototypes or ideas for custom products have enough potential to be worth pursuing, but this problem can be dealt with in a screening process conducted by marketing research; it should not be dealt with by the all-too-common practice of discouraging all information inputs with a policy such as "we don't do custom products."

Marketing research should be encouraged to accept proposals for custom products and user-developed products from sales and technical services and should be organized so that information transfers of this sort are easy and routine. In industries dominated by user-developed innovations, marketing personnel may be able to proceed directly to an exploration of the market potential of the user-developed product itself, just as if the design had come from the manufacturer's own research and development group.

Channels and incentives should be set up to encourage the transfer of information on users' product designs as well as needs from marketing research to research and development. And the latter should be encouraged not to design all new products "from scratch" but to use user designs — often available free — when appropriate.

Management has a role in creating these new arrangements and in keeping an open mind as to the outcome. Many companies start what turn into profitable product lines by making custom products or building to customer designs, then decide that these lines have grown so big that further involvement with custom products could be an unprofitable distraction from the companies' main goals; later such companies wonder why they are having difficulty finding the bases for new product lines.

### A Warning: Adopt Thoughtfully

Promising concepts for the management of innovations — and we believe that the management of user-developed products is one — are often prescribed too enthusiastically by researchers at a too-early stage — and then embraced too uncritically by practitioners. To avoid this, we wish to emphasize that strategies for the management of user-dominated innovation are not yet standardized. If you wish to apply the concept before it is routine, we urge you to approach the task flexibly and experimentally.

We are currently working with practitioners to apply these concepts; if you and your company are seriously interested, you are invited to talk with us about joining this joint research effort.

### User Innovation as a National Resource

The discovery that user-dominated innovation patterns account for the bulk of innovations in industries as important to the national economy as process machinery and scientific instruments raises a host of questions for government policymakers concerned with innovation.

Two implications for government policy can be postulated on the basis of research to date:

☐ A user-dominated innovation involves an extra transfer step — from user-innovator to commercial manufacturer — not required in the case of a manufacturer-dominated innovation. If the user takes the initiative in this step, the time lag associated with it may virtually disappear; but if the initiative is left to the manufacturer, the time lag from first successful application by the user-innovator to first sale of a commercial version by an equipment manufacturing company is often several years. Some ways to reduce this delay are inherent in the concepts we suggest above for better management by manufacturers of the process of acquiring user-developed products. But at least one avenue is open to government policymakers. Users in many industries currently have no effective financial incentive to hasten the diffusion of their innovations to others in the user community. They may, in fact, have a disincentive, to the extent that sole use of their innovation assures a competitive advantage over competing firms. A positive financial force to induce diffusion by increasing the incentive of user-innovators to transfer their inventions to manufacturing firms could bring significant benefits for many industries; it might even induce users to undertake innovations whose benefit to themselves is marginal but which might pay out handsomely on an industry-wide basis.

☐ It is clear that process innovations made by users in the U.S. are first transferred to U.S. manufacturing firms. In order to retain the innovations which innovative users are likely to spawn, the government could make special efforts to induce such firms to remain in the U.S.

We feel that policymakers should be particularly interested in process equipment innovations because of the growing evidence that process innovations (of which process equipment innovations are a subset), rather than increases in capital investment or labor skills, are the major sources of improvements in industrial productivity.

#### Further Readings

The author recommends the following additional readings for those with special interest in the field.

Two publications give details on the methods used by Professor von Hippel to determine the sources of new products in the two industries indicated; readers should find them useful in planning how to determine the sources of new products in their industries:

von Hippel, Eric A., "The Dominant Role of Users in the Scientific Instrument Innovation Process," *Research Policy,* July, 1976, pp. 212-239.

von Hippel, Eric A., "The Dominant Role of the User in Semiconductor and Electronic Subassembly Process Innovation," *IEEE Transactions on Engineering Management,* May, 1977, pp. 60-71.

The following suggests the means by which user-developed products are transferred to first-to-market manufacturing firms in one industry; it may give readers hints of possible patterns to look for in their own fields:

von Hippel, Eric A., "Transferring Process Equipment Innovations from User-Innovators to Equipment Manufacturing Firms," *R & D Management,* October, 1977.

Inputs from customers which are less than complete new products but nevertheless are useful to manufacturing firms are considered in:

von Hippel, Eric A., "A Customer-Active Paradigm for Industrial Product Idea Generation," Sloan School of Management Working Paper 935-77, May, 1977.

Before joining the faculty of the Sloan School of Management, where he is Assistant Professor of Management, **Eric A. von Hippel** was co-founder of a successful technology-based company and a consultant at McKinsey and Co., where he specialized in issues related to the management of research and development. His academic degrees in economics, engineering, and innovation studies are from Harvard (B.A. 1964), M.I.T. (S.M. 1968), and Carnegie-Mellon (Ph.D. 1974), respectively. The research reviewed in this article was supported by the National Science Foundation Division of Policy Research and Analysis. The author would also like to thank the M.I.T. Innovation Center for its support.

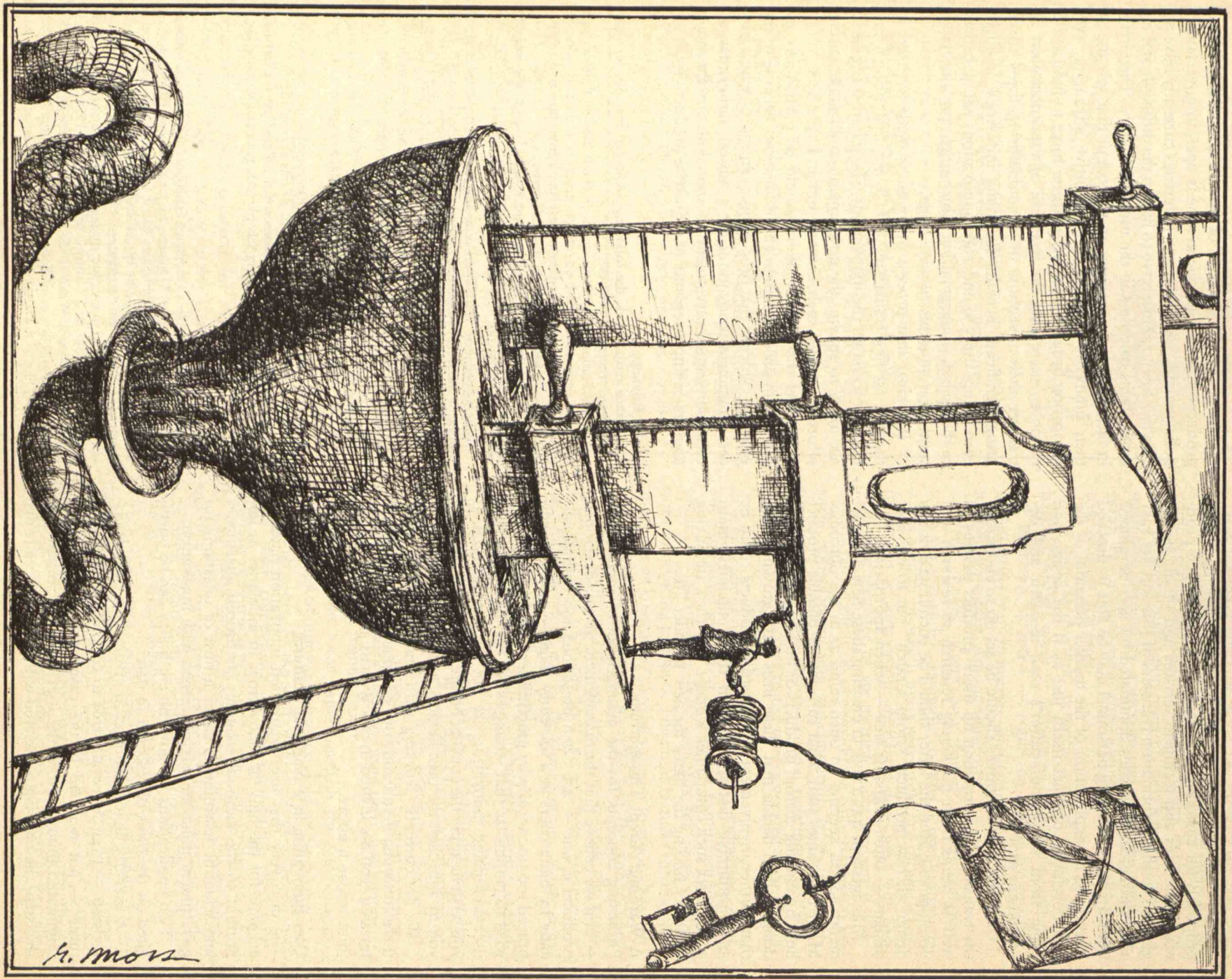



Illustration: Geoffrey Moss

# The Logic of Energy Conservation

Lee Schipper
Lawrence Berkeley Laboratory
University of California

Joel Darmstadter
Resources for the Future

When energy is short, conservation becomes our primary concern. But energy is still only the tail of the economic dog — one of a number of resources that must be used wisely.

Energy conservation is rapidly replacing the weather as a popular and vexing topic that everybody talks about. Our ability to overcome the misunderstanding on the subject remains in doubt, for energy conservation extends far beyond the mere reduction of energy consumption. In at least some of its dimensions, energy conservation may be more far-reaching and complex than most people imagine. But, properly understood, conservation is good for us.

There are two fundamental ways to save energy: either society can use less energy per unit of any specific good or service it produces; or society can shift toward a less energy-intensive mix of goods and services. Of course, conservation is not the only factor that can prompt this shift: for example, advanced industrial economies tend toward less energy-demanding service industries.

### Measuring Energy Conserved

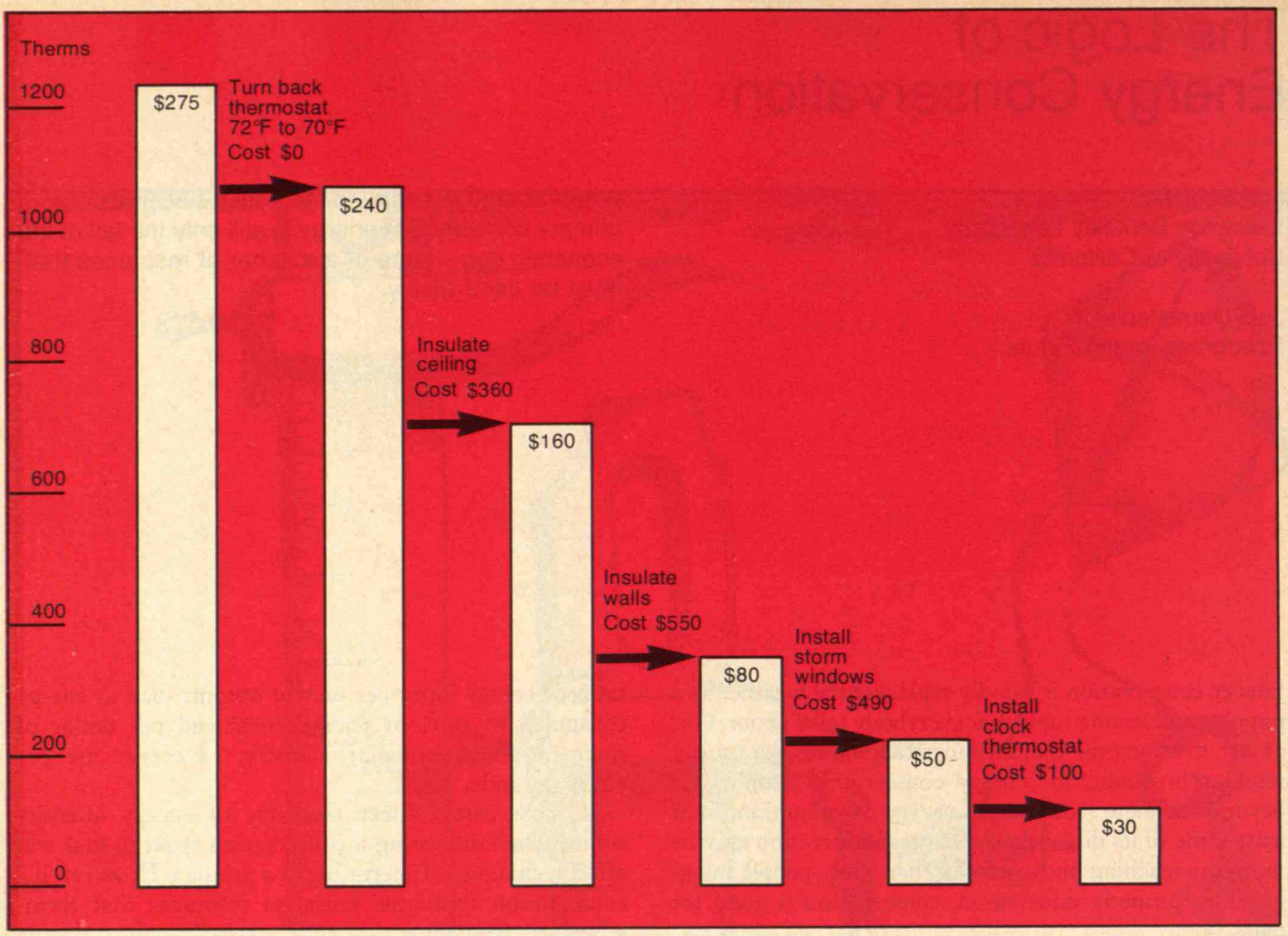
One complication in energy conservation is the actual measurement of energy consumption. The best unit we can use to measure energy inputs is the amount of primary resources in the economy (barrels of crude oil or tons of coal) required to produce a given product. Even if energy is conserved at an end-use or intermediary stage between production and consumption, it still should be discussed in terms of primary energy resources saved. For example, although a particular energy conservation measure may save only one unit of electricity, this indicates a savings of over three units of primary energy required to generate the electricity.

As conservation analysts, we also consider the non-energy resource inputs, such as labor or capital, which frequently are affected by changes in energy use. Output parameters may include such overall values as Gross National Product (GNP) or "industrial value added" in a specific product line; or they may include more specific measures such as passenger-miles travelled or tons of steel produced. Energy conservation measurement thus uses a ratio of energy input per unit of output, such as energy consumed to GNP, or energy consumed per dollar of shipment in a particular industry, or energy use per passenger mile.

In most cases, direct measures of energy intensity suffice when discussing a conservation strategy that will affect techniques of energy use in a product. However, if a conservation technique relies on resources that themselves are energy intensive (such as substituting an electric furnace for a blast furnace in steelmaking, or replacing iron and steel with plastics and aluminum in automobiles), indirect energy requirements should be included. Clearly, any changes in the consumption patterns of non-energy goods and services that alter the economy's energy requirements are complex, and must be considered on both a direct and an indirect energy-use basis. For example, the magazine you are holding represents consumption in many industries upstream from the printing press: this includes the trucking, the paper, and the chemical industries (for ink, chemicals for pulping, and chemicals for papermaking).

### Waste and Economics

We must be careful how we measure energy conserved, for many times it is unclear what conserving or wasting really means in human terms. Homemakers insulating their homes at a cost below their fuel bill savings are certainly practicing energy conservation; but if they acquire larger homes in the Southwest or North that require more fuel to cool or heat for a given level of insulation, it is certainly improper to say that energy is being wasted. If, on the other hand, the newer homes require significantly less energy per square meter per degree-day, then we may label these homes "energy conserving." Thus, measuring energy conservation and waste requires more than mere before-and-after quantities of energy used. Knowledge of the intensities of energy use and the type of economic activity must be included.




But intensity alone does not measure waste or efficiency. We doubt, for example, that trading a conventional refrigerator for a frost-free model is wasteful! The return for an unchanged level of cooling and the elimination of defrosting *is* higher electricity use, with subsequently higher bills. But such a choice is not an irrational response to a costly temptation to gadgetry. It is a trade-off of energy for time and drudgery. Similarly, substitution of automatic for manual transmissions in autos increases the energy required to operate the vehicle, but saves driver effort. Indeed, these illustrations themselves suggest that overuse or abuse of words like "sacrifice" or "Moral Equivalent of War" may blunt consumer interest in conservation.

Thus, we see that energy use alone is not a sufficient yardstick with which to measure optimality. One person's frivolity may be another's necessity; last year's indulgence, this year's need. While intensity is a physical measure, efficiency is an economic measure that requires measurement of all resource inputs.

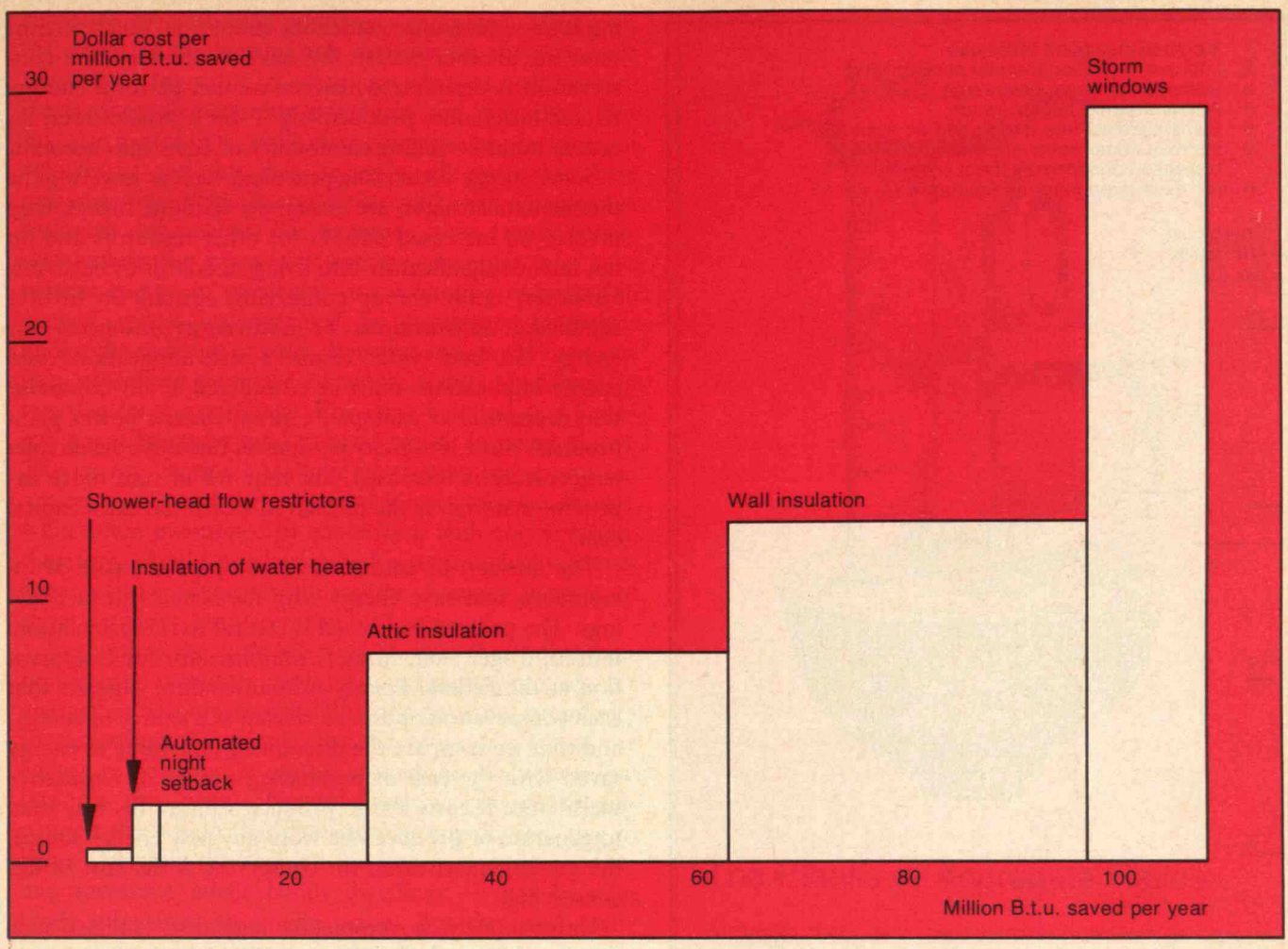
In this light, each individual consumer should be allowed to divide up his or her energy needs (and other resource uses) into a spectrum ranging from the absolutely necessary to the absolutely unnecessary, and structure his or her life accordingly. Needs and wants, frivolities and necessities, depend on cost and perceived benefit. Denunciations of one sort of waste or another therefore should be viewed somewhat skeptically.

This leads us to the central principle which, in our opinion, should underlie any conservation policy or discussion: conservation involves changes in resource use or preferences that, in the eyes of the people conserving, maximize well being. Conservation is a means to greater welfare, not an end in itself. The most impelling factor in encouraging conservation action is the cost of not conserving.

Because of the welfare-enhancing characteristic of conservation, we question the curtailment of energy supplies (gasoline rationing, for example) as a conserving technique. Curtailment would be acceptable and appropriate if it were part of a planned emergency policy package, designed to effect rapid reduction in energy demand with minimal social and economic dislocation. Similarly, measures aimed at limiting economic growth in the interest of saving energy affect well being by restricting economic productivity by the misallocation of scarce resources. These measures may be considered appropriate by those who believe a moderation of economic growth to have virtue in its own right; they do not belong within the conservation framework.

### How to Conserve Energy — and How Much?

We have said that conservation, properly viewed, is actually the opposite of sacrifice, given rises in fuel prices or




other conditions such as environmental decay. If we accept this attractive definition of conservation — and virtually every careful study of the subject (*see charts above*) points to the economic rewards — then what do we do to conserve?

☐ Substitute other resource inputs for energy (insulation investment to reduce the energy needs for heating, for example);

☐ Change our habits, preferences or operating procedures to reduce energy use (lower thermostats or increase maintenance of industrial boilers);

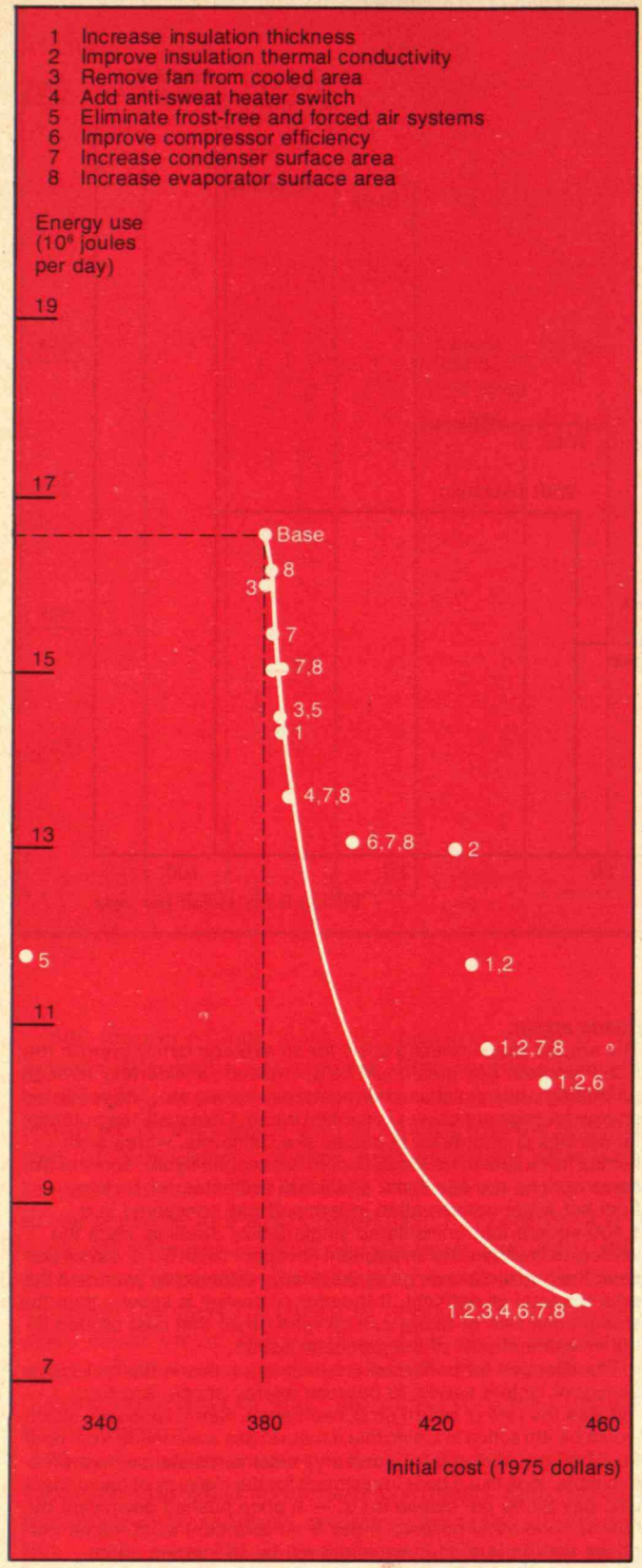
☐ Change the mix of goods and services to demand less energy (take vacations in less distant spots).

These three responses to concern about energy use should be the primary focus of conservation strategies. In strategies of the first type, studies indicate that in many important applications, most notably process and space heating, conservation technologies can reduce the energy requirements per unit of activity by 30 to 80 per cent of today's use (*see p. 44*). Behavioral and preference changes might affect where we live, how far we travel, how many appliances we have, and what kinds of indoor environments we prefer, but it is generally acknowledged that innovative technical changes offer far greater savings in energy in the next 30 years.

While the literature (including back issues of *Technology Review*) abounds with technical prescriptions for sav-

*Charts above:*
The annual space-heating costs for an average family living in the San Francisco Bay area could be decreased considerably through retrofitting with insulation, thermostat set-backs, etc. The predicted energy savings are shown in the first figure. Obviously the potential for savings is enormous in places like California, where most homes have little or no insulation. In the second figure, some of the same options are seen with additional estimates on savings from hot water conservation in terms of gas conserved in a 1,400-square-foot uninsulated single-family dwelling. Here the vertical axis shows the investment cost per million B.t.u. saved per year; the horizontal axis gives the energy savings per year, and the area the total investment. If the cost of energy is known, then the straight-line rate of return can be read off as that cost divided by the investment cost of the particular option.

The dilemma for policymakers, of course, lies in the fact that a variety of factors serves to depress energy prices, and thus reduces the rate of return on conservation. Storm windows, which would be attractive in California if natural gas were made from coal (at $4.00 per million B.t.u.) or if only electric resistance heat were available, look like a poor investment for the majority of consumers who pay $2.00 per million B.t.u. — a price pushed downward by controls and other policies. If gas is so abundant as to render low prices appropriate, then we might not be concerned about "conserving" gas. But if, as many suspect, gas is more scarce than its price suggests, then most consumers will overconsume by underconserving and pass up opportunities to save that fuel. (The full documentation of "Two Zone," by Arthur Rosenfeld, et al., is found in Lawrence Berkeley Laboratory Report LBL5271.)




Improved technology can cut energy use — and the total cost of owning and operating a refrigerator — by conserving energy. An improved refrigerator merits some additional expense because it can cut energy use enormously. Moreover, the rate of return on such an investment, while dependent upon the price of electricity, almost always exceeds 25 per cent per year. In the above chart, daily energy use (or intensity) is plotted against the first cost of a 16 cubic ft. top-freezer refrigerator incorporating the given options. In this case the technologies are all available: some refrigerators incorporate them already. (Haskins and Hirst, Oak Ridge National Laboratory, 1977.)

ing B.t.u.s, economic guidelines about how much to conserve are another matter. We have emphasized that conservation is desirable whenever we can perform energy-related tasks more productively — for a smaller total resource input — taking the totality of costs into account.

Some energy conserving practices, such as lowering the thermostats at night, are essentially costless; that is, they involve no increased outlays for other resources and do not intrude significantly into living standards or behavior. However, many energy conserving options do involve significant substitutions or non-energy resources for energy. So both total resource-cost implications and energy implications must be considered in any conservation decision. For example, a steam-electric power plant produces more electricity per unit of fuel if the steam inlet temperature is increased, but requires in turn more expensive material. Is the fuel saved worth the extra capital cost?

The answer, of course, is to compare the cost of investments that save energy with the benefits of fuel savings. The price of fuel saved is central to this calculation. Indeed, Roger Sant, former Administrator for Conservation at the Federal Energy Administration, suggests that each conservation option be viewed as a source of energy, and that we compare the discounted unit value of energy saved with the cost of purchasing similar or alternative fuels. Since it costs less to produce a B.t.u. this way than to generate or produce one from any new energy source, the greatest motivation for conserving is the cost of not conserving.

Unfortunately, governmental regulatory policies such as oil and natural gas price controls, utility pricing practices, or subsidies to producers — which artificially depress price — keep the consumer from seeing or paying the marginal or replacement cost of producing the next unit of energy. This replacement cost is significantly higher than the prevailing average or historical cost. Consequently, each energy user's incentive to conserve energy falls below the economic optimum, which is set by the marginal cost. Worse, environmental costs often still are excluded from the balance sheet. Nevertheless, even with these problems, a given set of energy prices allow us to find out how much energy the economically rational user would conserve.

Bear in mind that short-term measures such as add-on investments in insulation and lowered thermostats affect energy use significantly, but by no means do they equal the impact of replacing inefficient equipment in the natural course of economic growth. New investment ushers in the most dramatic drop in energy intensities. Ironically, the faster the economy grows, the larger the opportunity for conservation, if one subscribes to this notion.

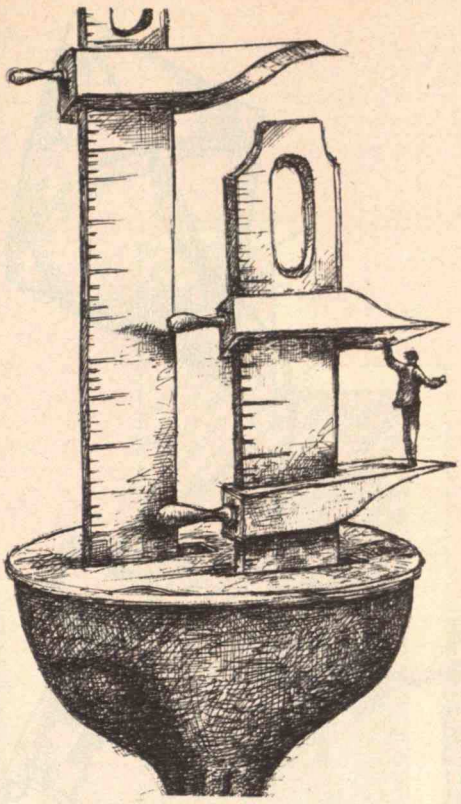
The fact that new capital equipment offers the largest and cheapest energy savings per unit of investment bears comment. First, while cars and appliances are discarded within years, structures and manufacturing equipment last for many decades. Those intent on seeing conservation bite deeply thus need to be patient: indeed, the ultimate potential conservation in buildings or industry alone over a 30-year period is greater than the total energy con-

sumption for autos and appliances combined. Moreover, the speed of implementation depends on the economic rewards — the value of energy saved — as well as standards or implementation programs and incentives. But this also means that, while restricting the use of recreation vehicles or gaslights may be politically symbolic, these measures save little energy compared with imaginative technical approaches. For example, mass transit, while worthwhile for many non-energy concerns, may save neither energy in particular nor economic resources in general unless accompanied by regulatory incentives and/or the redesign of cities. Recall that today the tax system subsidizes purchase of single family dwellings in low-density surroundings. This may be good social policy, but it has been fatal to mass transit in many places. The energy "waste" symbolic of existing transportation arrangements and the presumed virtues of mass transit, while often mentioned in connection with conservation, therefore, should not be pushed too strongly by energy conservation advocates unless the broader aspects of those activities are also taken into account.

Evaluating the kind of conservation that substitutes non-energy resources and new technical practices for energy has become the speciality of a growing community of researchers. We think that the value or price of the energy to be saved is central to such an evaluation *(see box on this page)*. Nevertheless, we frequently encounter the notion that demand is not really sensitive to price. Certainly the demand for some amenities — driving, vacations, single family dwellings — may be relatively insensitive to energy prices. But the least costly ways of providing these and other energy-using amenities do depend on energy costs. Thus "how much to conserve" depends on consumer tastes as well as technology and pricing trends and policies.

The Swedish experience, which we have studied extensively, reinforces the notion that energy price helps determine the choice of energy-using equipment. Faced with energy costs traditionally 25 to 100 per cent higher than in the U.S., Swedish factories opt for more efficient processes and practices in producing their extensive selection of energy-intensive goods. Swedish autos average 24 m.p.g., and Swedish single family dwellings use less fuel for heating than those of the same size in the U.S., in spite of a tremendous climatic difference.

Yet Sweden is by no means an "ideal" energy consumer. This suggests that there is no definable limit to conservation, at least not until we approach both thermodynamic limits and the exhaustion of our ingenuity to modify and refine tasks. Conservation, depending as it does on the evolution of energy costs and technology, is not a one-time option, but rather a continual reevaluation of the mix of resource use that allows us to minimize the total cost of resources used to achieve an end. For this reason, conservation planners should look ahead and avoid taking measures that will foreclose even more beneficial practices in a future where energy prices and other resource costs will change. For example, restricting the area of windows to reduce heat losses would be foolish; that regulation might deprive builders or architects of the option of using large windows as passive

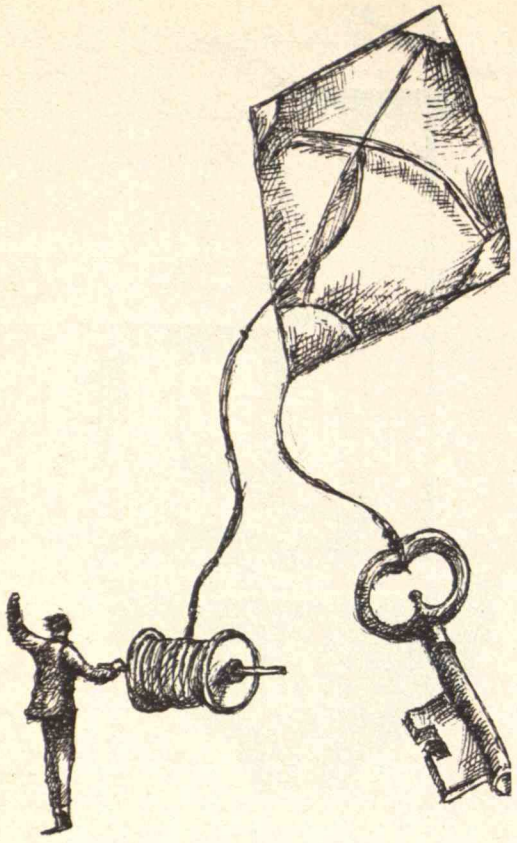


## The Pitfalls of Aggregate Ratios

Although there have been numerous studies and much debate over the value of energy/GNP ratios in predicting demand, the aggregate nature of both the numerator and denominator in the ratio warn us to treat this number with extreme caution. Superficially, the ratio is a rough indication of how much energy it takes to sustain a given standard of living, insofar as GNP measures standards of living. The difficulties in evaluating and comparing GNP from a single country over time or among countries are well known. More important, the joint use of GNP and energy totals obscures economic and demographic factors.

For example, energy-use totals generally do not differentiate among particular kinds of energy, each of which have characteristic thermodynamic properties and prices. Also, the influence of climate is seen in the demand for fuel and for space conditioning, but is not reflected directly in the GNP, as is the geography and density of countries and regions. The energy embodied in products that make up the bill of import or export goods should also be kept in mind.

Unfortunately, single ratios relating energy to labor, capital, or output, especially in the aggregate, have become the popular vehicle for spirited but often uninformed analyses, ironically by both those who speak for the energy industry, such as *Energy, the Economy, and Jobs* by Winger and Nielsen of the Energy Group at the Chase Manhattan Bank, and by certain environmentalists, such as Barry Commoner in *The Poverty of Power*. Both these analysts attribute far more meaning to simple ratios than we would accept, given the subtleties of economic and political conditions that guide energy use, efficiency, and conservation. — *L.S., J.D.*



## A Conservation Paradox

The neglect of socio-economic factors can seriously hinder energy conservation policy. For example, district heating systems have been proclaimed by many as an excellent energy conserver, for they use waste heat from power plants or industrial processes to heat whole communities. But the Swedish experience with these systems has shown that the people using the systems can still waste energy. Apartments in Sweden which are heated by central systems are rarely metered on an individual basis, so there is no individual incentive to control temperature to save money. And the systems are not easily regulated, for usually there are no thermostats that measure indoor air temperature. Heat should be regulated by turning the radiators off or on. However, most Swedes have developed a more precise technique for controlling heat — opening the windows. As a result of these practices, the use of energy for heat in Swedish apartments is nearly as high per square meter as for single-family dwellings, even though in theory heat use should be considerably lower. — *L.S.,J.D.*

solar heat collectors.

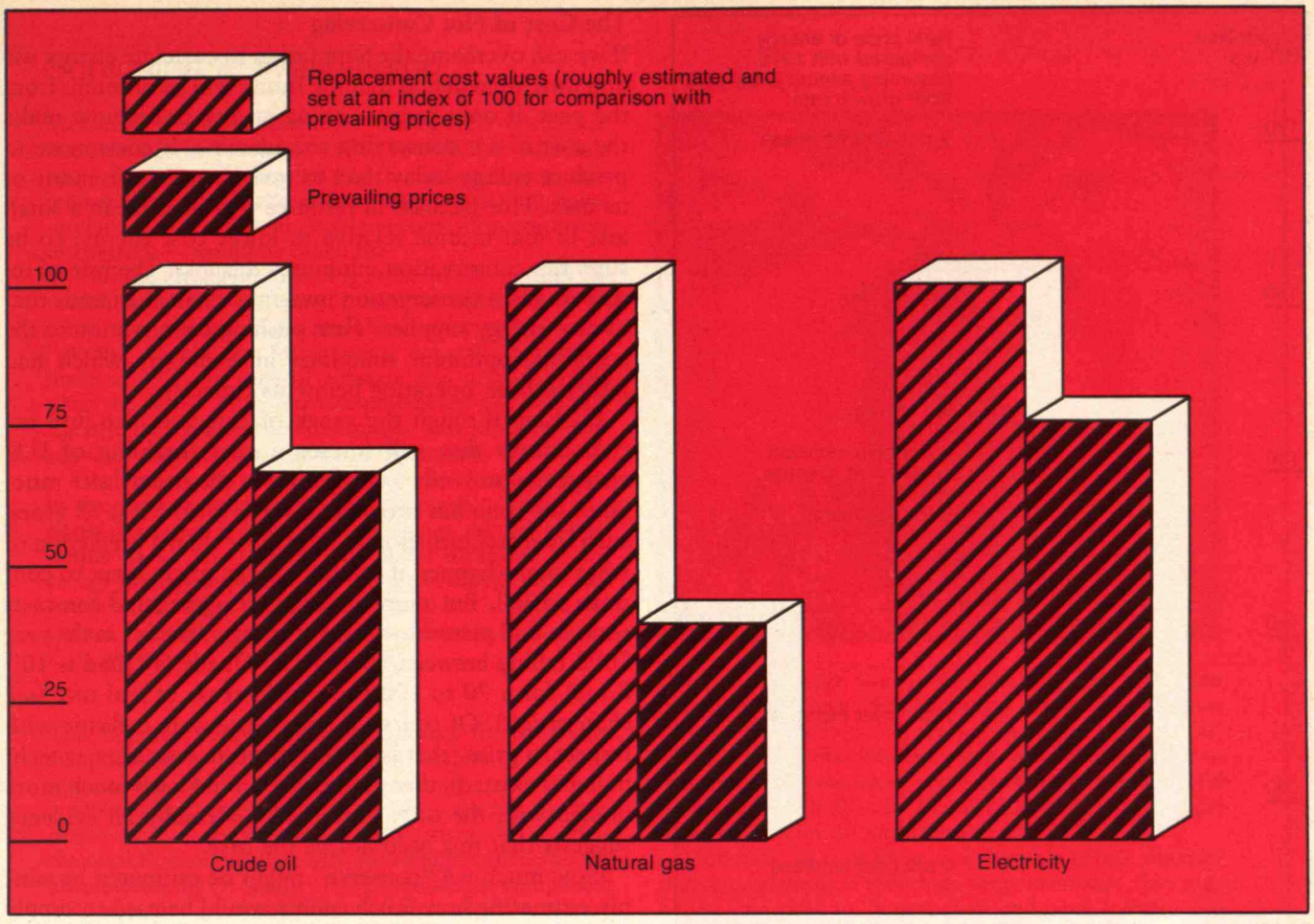
There is also the question of how consumers would handle conservation measures that reduce energy use and thus lower cost, but also change their perceived amenity levels. Some resource substitutions that lower the cost of a given amenity might stimulate users to seek greater levels of that amenity, bringing it back up to a previous level. For example, a well-insulated home might spur the homeowner to keep his thermostat turned up, incurring the same heating costs as the homeowner with a lower thermostat in an uninsulated home.

Conversely, there may be consumers who, rather than blunting the impact of higher energy costs through substitution, are willing to accept less amenable conditions. These people would lower the thermostat rather than insulate. Researchers feel more secure dealing with the substitution case because it is susceptible to unambiguous cost-benefit calculations; but we should not discount the possibility of more elusive behavioral changes interacting with those that are economically deterministic.

Some consumers, given information, encouragement, and the incentive of more costly energy, may adapt their behavior to drive less than otherwise, heat less than otherwise, and use fewer appliances. Others will first investigate all the possible energy-conserving technical possibilities, such as insulation, energy-monitoring devices, and other options for existing or new homes and autos, before they adopt less energy-intensive habits. Predicting these two disparate responses is important to conservation policy research and development. Consumers do not easily relinquish amenities — many of which are energy-intensive activities or products that grew in importance as energy prices declined — related to comfort, convenience, and mobility. But this does not preclude the exploitation of attractive opportunities for technological energy conservation, which may be determined by energy prices and policies. Mobility is not curtailed while energy is conserved if, for example, automobiles are made of light aluminum rather than steel.

However, we must emphasize that only a few non-energy goods and services are energy-intensive (measured in B.t.u. consumed per dollar of final demand). Changes in energy prices will have only a small effect on the prices of most of the consumption decisions involving these activities. Energy is still the tail of the economic dog, and it seems reasonable to assume that other economic or social forces might be felt long before energy costs change the mix of goods and services consumed. Energy, notwithstanding its importance when suddenly unavailable, nevertheless accounts for only about 10 per cent of the total income we spend. Conservation, therefore, must not be oversold for its own sake, unless the value of conserving (whether easily expressed in an engineer's equation or understandable only as a contribution to national security or environmental well being) is made clear. Conservation does not justify expensive fixed-rail mass transit systems, whose energy conserving status is questionable. Energy use per mile is not the only criterion for "efficient" transportation. By the same token, such systems need not always fall back on energy conservation or on conventional profitability guidelines to be "sold" — other characteristics, such as reductions in pollution or congestion, may be of equal value.

Nevertheless, we believe that energy will be conserved primarily by technical means, although gradual changes in behavior and lifestyles will help as consumers find themselves as well or better off using less energy. We speak with certainty: the future will be somewhat different than the past. The cost of energy will probably rise




Economic efficiency is best served when the price paid reflects what it would cost to replace or produce one additional unit of the product in question. In the U.S., energy products continue to be priced on a basis far short of replacement values. As a result, demand has been higher than it might be, and a barrier has been created to investment in conservation.

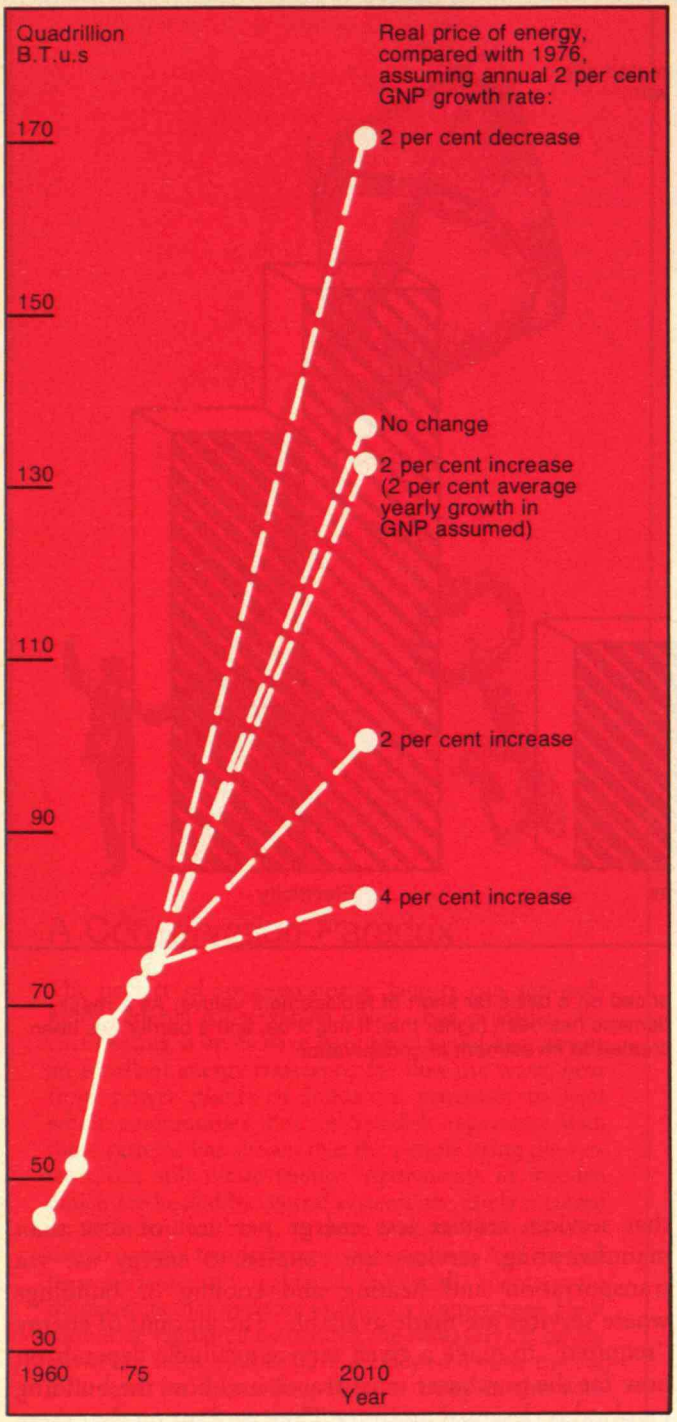
toward the end of the century; innovation and common sense will allow us to respond to higher costs by saving that which is dear.

### Energy and GNP

When all the different energy uses are added together and compared with changes in the GNP, the two measures seem to be well correlated historically, with GNP growing slightly faster.

In general, the energy required to support a certain GNP is determined by both the make-up of the GNP and the intensity of energy use. Also, countries where (or eras during which) a relatively higher portion of energy is delivered to final demand (as in the U.S.) would tend to have a higher energy-to-GNP ratio than countries with similarly structured intermediate demands but lower demand for comfort heating and personal transportation. Energy delivered directly to final demand "produces" less GNP than the energy combined with other resources to produce the goods and services that make up most of the GNP. Even the relative shares of manufacturing and services need not predetermine the energy/GNP ratio. While it is widely held that services require less energy per unit of GNP than manufacturing, services are coupled to energy use via transportation and heating and cooling of buildings where services are made available. The amount of energy "required" to make a given service available depends on how far the purchaser must travel, and how the building involved is designed and run. Thus we caution that there are few firm rules that apply to understanding the relationship between energy and GNP. Energy and economic activity must be considered separately and in detail before any great conclusions can be drawn about the aggregate "efficiency" of energy use.

A recurrent theme of this essay has been that energy is but one of many resources that combine to produce goods and services. Simple aggregated ratios, such as energy/GNP or energy/worker, enjoy popularity in discussions of present and future energy needs. These ratios, however, omit two things: explicit consideration of structure, and substitution of resources. Most reliable information about energy use, needs, and conservation comes only from a detailed examination of the uses and factors that influence the uses of energy with other resources.




Neither U.S. economic history nor comparisons with other industrial countries point to a unique relationship between a nation's economic growth and its use of energy. One recent attempt to project U.S. energy-economy linkages over the next 30 years finds that, depending on the course of future energy prices and a corresponding pursuit of cost-effective conservation possibilities, a given rate of GNP growth might occur with a wide range of energy growth rates. Of course, one should not be dogmatic in such views, as the future contains many surprises.

The hypothetical (and preliminary) forecasts were developed by the Demand/Conservation Panel, Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences. Historical data from Bureau of Mines are plotted at 5-year benchmark intervals. All alternatives assume average yearly GNP for variant $B_1$, at 3 per cent. In all cases, assumed GNP rates are higher during early decades, lower toward end. Assumed yearly increases (or decreases) in real energy prices were: A, 4 per cent; B and $B_1$, 2 per cent; C, no change; D, minus 2 per cent. Trends to 2010 are not assumed to be linear.

## The Cost of Not Conserving

If we can overcome the temptation to correlate energy use and GNP, we will find that the future will be different from the past, if only because rising energy prices now make the cost of *not* conserving considerable. It costs more to produce energy today than to save it, at least in many of its uses. This increase in resource cost does mean a small loss in real income relative to lower cost energy, to be sure. But conservation minimizes this loss. The rate of return on most conservation investments often exceeds that of new energy supplies. Thus pushing conservation to the economic optimum stimulates an economy which had hitherto been operating below its capacity.

Looking through the range of forecasts, we find extrapolations that still foresee a near doubling of U.S. energy use and only a small drop in the energy/GNP ratio. Since the ratio has dropped anyway for the last 75 years, such forecasts incorporate little more than a prediction of what might happen if relative energy prices were to continue to fall. But more detailed, disaggregated forecasts seem to find plausible a level of energy "needs" in the year 2000 falling between 90 and 120 Quads (a Quad is $10^{15}$ B.t.u.) for a 70 to 100 per cent increase in real GNP (*see chart at left*). Of course, if energy use were inelastic with respect to price (that is, if no substitute resources or technologies existed), then energy use would keep much more in step with the GNP. Fortunately, virtually all evidence suggests that this need not be the case.

How much we "conserve" might be estimated by simply estimating how much energy would be used to supply a given quantity of goods and services in the year 2000 at today's intensities, and reestimating the amount at tomorrow's (conserving) intensities. The difference would be attributable to conservation. Further, the likely mix of activities in the year 2000 will be intrinsically less energy-intensive, largely because we can drive only so much or heat so much space, two activities that in the past slowed the drop in the energy/GNP ratio considerably. All things considered, the amount of energy we conserve will depend on energy prices, technological development, lifestyle, tastes, policies and, of course, the rate of turnover of our capital stock. Again we emphasize that conservation, while unlikely to reduce the absolute amount of energy consumed, will slow the growth in that consumption, easing supply problems but *not* eliminating them all together.

Policymakers need a clear understanding of the effects of energy prices on a consumer's motivation to conserve. As we have said, prices may affect a homeowner's choice to insulate or to simply lower the thermostat. We should be wary of projections of future energy "needs" based only on historical data — or projections that ignore experience — if they do not reflect the future possibilities and motivations, both economic and otherwise, toward conservation.

Similarly, we must exercise caution when using highly aggregated statistics to project energy needs. The demand for goods and services produced with energy may decrease if energy costs rise. Estimating the energy impacts of any group of decisions will be extremely difficult be-

## Confusion In Washington

Measuring energy conservation confused the Carter administration. In February, 1977, both Walter Mondale and John O'Leary (then head of the Federal Energy Administration) said that "sacrifices" such as installing home insulation — a rather profitable venture of questionable discomfort — would be called for.

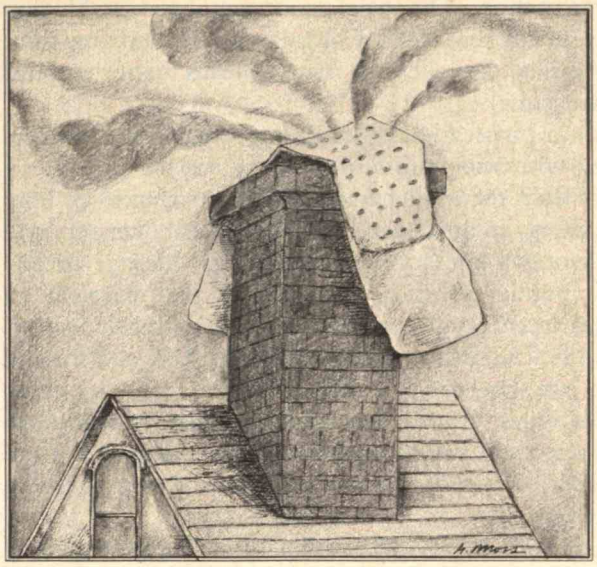
Thus the President, following constant advice from the media, hinted that we weren't doing enough; look at all those gas guzzlers, he admonished. Yet today's cars "guzzle" 25 per cent *less* gasoline per mile than those made in 1973, in spite of constant real gasoline prices after the initial price increases following oil embargo. Clearly, the President and the public have confused perceptions about conservation and its measure.

To eliminate this confusion, we can describe energy use by denoting the level of physical or economic activity in a particular sector x as $O_x$, and the energy use per unit of output as $I_x$. The intensity (I) can be measured as the energy directly applied, or as the direct energy plus that embodied in other resources also used but supplied upstream. In either case, the energy consumed in this activity $E_x$ is given as:

$$E_x = O_x \times I_x.$$

This notation suggests that we consider the total consumption (E) as the product of two vectors $\vec{O}$ and $\vec{I}$ — representing, in effect, the entire economy.

Obviously, changes in either the $O_x$ — the mix of activities — or $I_x$ — the intensity of each activity — can affect the total E. Economic growth, for example, increases the absolute size of O. Smaller homes reduce the component of O related to space conditioning, while added insulation reduces the intensity of heating. Some measures, such as small cars, involve changes in both O and I; lifestyle or behavioral changes often fall on this boundary. During the post-war period for example, ownership and use of autos increased far faster than GNP, a factor that tended to push up the energy intensity of the whole economy. At the same time the manufacturing sector decreased in energy intensity. Obviously, sole consideration of total use or of oil imports would obscure the important dynamic



changes in energy use or imports. $I_{auto}$ has decreased dramatically since the embargo, while the distance traveled per capita by car has not increased at its historical rate. Given that gasoline prices have not increased in real terms after the initial spurt in early 1974, one would have to conclude that the U.S. is conserving energy in the important sector of auto transportation.

Moreover, as consumers and business people discover that there is profit in reducing energy intensities, they may be less interested in "moral war" and more interested in obtaining loans, grants, or at least competent advice covering profitable conservation investments. Great lifestyle changes (notably changes in the relative values of the $O_x$) may occur over longer periods of time in response to energy and other concerns. But talk of conservation must sort out the definitions of conservation and focus on the proper measure: what is being conserved. After all, confusing a sacrifice with a benefit is no small matter. — *L.S., J.D.*

cause of the complexity of energy requirements of various mixes of activities. Even the often cited trend from manufacturing-oriented to service-oriented industries can, as we have indicated, be misread. Supposedly a service-oriented society would be energy conserving, but services include home upkeep, hotel stays, and gasoline, while manufactured goods include fishing gear, handheld calculators, and citizen's band radios, all with energy intensities considerably below the national average. Thus, we need to know which goods and which services the future will bring before prognostication about energy can be reliable.

Just as energy conservation is a response to a new energy price era, so significant substitution away from energy can dampen price pressures and permit a less convulsive development schedule for energy sources that now are technically, politically, financially or environmentally uncertain. And our early introduction of energy conservation measures will mean that the rate of usage of the new resources — which may or may not be environmentally benign — will, at any given time, always be lower in the future than if we had not begun to use energy more sparingly.

### Some Enduring Complexities

As we have said, energy conservation reflects the response of energy users to factors dominated by, though not necessarily limited to, prices and scarcity. Other interconnected issues include policies dictated by national security, environmental quality, and social impacts. Our understanding of the economics of substitution of non-energy resources for energy is improving; our knowledge about the speed of behavioral change or shifts in the mix of goods and services as a function of energy prices and policies remains far from perfect. In any case, we deem it important to delineate some of the principal forces that

activate the conservation response, observing however, that the mere existence of these possibilities and a discussion of where rationality seems to lie does not guarantee implementation. (The social equity implications of higher energy prices that deter Congress from removing price controls illustrate one such issue, but this matter requires its own essay.)

From a physical standpoint, important tasks are performed with widely differing energy intensities, and we are far from thermodynamic limits. Our choices of how much energy to use depend on how the cost of energy and its substitutes interact with technology, lifestyle preferences, public policies, and institutional barriers to changes in energy-use patterns that could result in conservation. The historical record of both U.S. and foreign energy use shows considerable flexibility in energy needs — seen either from a technical (resource substitution) viewpoint or a behavioral/lifestyle viewpoint. Thus we can expect that conservation will play a great role in the energy future.

Keep in mind that conservation is not simply an issue of waste versus non-waste; the boundary line between these two extremes is defined both by economics and by tastes and preferences. In this light, however, it is nonetheless possible that growing worldwide energy consumption is raising consciousness among people in industrial nations over the moral implication of high — or low — energy consumption levels. While our economic definitions of energy conservation imply that economic considerations may be the most important criteria for determining the desirability of energy conservation strategies, we recognize the collateral importance of such difficult questions as waste, lifestyles, and growth itself in connection with energy conservation. But from the standpoint of clarity, these issues are best taken up on their own merit. If our discussion appears, therefore, to have imposed narrower bounds on the scope of energy conservation than some persons would prefer, meaningful payoffs — to energy users and to society — can still derive from soundly conceived conservation approaches within even a restricted framework. Perhaps the most pressing need for research today is to identify such payoffs — in their physical, economic, and social dimensions. We suspect that energy conservation offers the potential of large benefits to society. If that is so, conservation will play a decisive role in future demands for energy resources.

**Further Readings**


Berndt, E. R. and Wood, D., "An Economic Interpretation of the Energy-GNP Ratio," in M. Makrakis, ed., *Energy: Demand, Conservation, and Institutional Problems,* Cambridge: M.I.T. Press, 1974, pp. 21-30.

Craig, P., Darmstadter, J., and Rattien, S., "Social and Institutional Factors in Energy Conservation." *Annual Review of Energy,* Vol. 1, pp. 535-551, Palo Alto, Calif.: Annual Reviews, Inc., 1976.

Darmstadter, J., Dunkerley, J., and Alterman, J., *How Industrial Societies Use Energy,* Baltimore, Md.: Johns Hopkins University Press, 1977.

Hoskins, R., and Hirst, E., *Energy and Cost Analysis of Residential Refrigerators,* Oak Ridge, Tenn.: Oak Ridge National Laboratory Report ORNL/CON-6, 1977.

Hogan, W., and Manne, A., "Energy-Economy Interactions: The Fable of the Elephant and the Rabbit?" in Hitch, C. J., ed., *Modeling Energy-Economy Interactions: Five Approaches,* Washington, D.C.: Resources for the Future, 1977.

Linden, H. R., *Resource, Economic and Historical Considerations Related to Issues of Energy Policy;* and Parent, J. D., 1974. *Some Comments on Energy Consumption and GNP,* Chicago, Ill.: Institute for Gas Technology, 1975.

Long, T. V. and Schipper, L., *Energy Needs and Resource Substitutions,* prepared for Joint Economic Committee hearing, November 17, 1976 to be published in *Energy,* Fall, 1977.

MacDonald, S., *Petroleum Conservation in the U.S.: An Economic Analysis,* chapter 4, "Conservation in the General Economic Process," Baltimore, Md.: Johns Hopkins Press, 1971.

Nordhaus, W., "The Demand for Energy: International Perspective," *Proceedings of the Workshop on Energy Demand,* pp. 511-587, Laxenburg, Austria: International Institute for Applied Systems Analysis, 1975.

Pilati, D., "Residential Energy Savings Through Modified Control of Space Conditioning Equipment," *Energy,* Vol. 1, pp. 233-239, 1976.

Rosenfeld, A., et al., Lawrence Berkeley Laboratory Report LBL-5926 and LBL-5271 (preprint), 1977.

Schipper, L., "Raising the Productivity of Energy Utilization," *Annual Review of Energy,* Vol. 1, pp. 455-517, Palo Alto, Calif.: Annual Reviews, Inc., 1976.

Schipper, L. and Lichtenberg, A., "Efficient Energy Use — The Swedish Example," *Science,* Vol. 194, pp. 1001-1013, 1976.

Williams, R. and Ross, M., "The Potential for Fuel Conservation," *Technology Review,* Vol. 79, pp. 49-57, February, 1977.



**Lee Schipper,** formerly Energy Specialist with the Energy and Resources Group, University of California, Berkeley, is now a researcher at the Lawrence Berkeley Laboratory investigating energy conservation opportunities in Sweden as a guest of the Royal Academy of Sciences, Stockholm, with support from the American Scandanavian Foundation and the Fulbright Commission.

**Joel Darmstadter** is a Fellow with Resources for the Future, Washington, D.C. He is co-author of *How Industrial Societies Use Energy,* recently published by Johns Hopkins University Press.



The original version of this essay, *What is Energy Conservation* was prepared as Lawrence Berkeley Laboratory Document LBL-5919 for the Committee on Nuclear and Alternative Energy Systems of the National Academy of Sciences. The authors participated on the Demand conservation Panel of that Committee. This work was done with support from the U.S. Energy Research and Development Administration.

# An Agenda for Technology and Policy

We have by no means exhausted the contributions of science and technology. We need only an enlightened public to weigh their benefits.

Frank Press
Director
Office of Science and Technology Policy

Frank Press: science and technology present a host of opportunities, a plethora of intriguing alternatives. But "no group has the wisdom or foresight to plan how whole societies, not to mention all of mankind, can or should advance down any single path of development," writes the President's Science Adviser. (Photo: Roger N. Goldstein)

Any discussion of present and future science and technology policy — government decisionmaking that rests not only on what is scientifically true and technologically feasible but on what is politically obtainable — requires a somewhat new perspective on the two great forces of science and engineering. For there is still much misunderstanding involving science and engineering themselves and the social roles they play and can play.

One of the great difficulties we face — and by "we" I mean those of us in science and engineering as well as the general public — is our innate optimism. Most of us are not cynics. We tend to believe that for every problem there is a solution. More than that, a great number of us are basically utopian in our outlook. We feel that if a certain number of major problems could be solved, mankind could come close to achieving, if not a heaven-on-earth, at least a decent world community free from most of the conflict and deprivation apparent today. Of course, different people envision this in different ways. There are those whose vision encompasses simply global peace and satisfaction of basic human needs. There are those who go beyond that to call for a system of continuing economic growth — with equity. And there are those whose nirvana is a no-growth world, one that has achieved a steady-state — physically, economically, and in terms of human satisfaction.

Over the past few decades our utopian expectations have been reinforced by a series of scientific and engineering triumphs that have exalted our spirits and raised new hopes. Various breakthroughs have held different promises: antibiotics would wipe out disease; the atom would be an endless source of energy; the "green revolution" would conquer world hunger; automation would eliminate human toil while computers took care of mental drudgery; and jet travel and satellite communication would unite the world in a new era of understanding.

Where did these miracles of science and technology fail? They didn't. They have all made important con-

tributions — and continue to contribute. What has failed has been our understanding of the nature of the dynamic system in which new concepts and technologies fulfill and create expectations almost simultaneously. The new expectations in turn generate new dissatisfactions, instabilities, and demands for further change — not only for new technologies but also for new social and economic concepts and the institutions to implement them.

The process is further complicated by the fact that, as long as we are confined to this planet, all this takes place in a world of finite resources and in a complex and somewhat fragile closed ecological system. In addition, as I shortly discuss, the whole system is now threatened by major geophysical perturbations, such as large climatic changes, which our modern world has yet to experience.

**Toward New Realities of Limits and Interdependencies**

Only in relatively recent years have all this complexity and its implications begun to dawn on us. Yet a surprising number of people (some scientists included) cling to the hope of simplistic solutions. For example, we still hear echoes of solutions to the energy problem based on back-of-the-envelope calculations that tell us such irrelevant things as these: the earth's geothermal energy at an average depth of 6,000 meters could provide all the energy we would ever need; the deuterium in the world's sea water could release through fusion the energy equivalent of 500 Pacific Oceans of petroleum; the amount of uranium in the world's granitic rock could provide the world's energy at many times the current rate of consumption for thousands of years; or the sunlight falling on some small percentage of the earth's land area could give us a similarly immense amount of energy for as long as the sun shines. Some believe that huge supplies of oil and gas are still available to be tapped if only the price were right.

Such oversimplifications seem to tell us there is no energy crisis — that there are merely a few technological problems and restrictions on the free market between us and an energy millenium. But we know differently; and we have the same sense about material resources, food, water, and all our other human needs. There are no ultimate or singular technological fixes, nor is everything available or possible simply by providing enough incentive. We have lost our innocence. Today we recognize both the enormous engineering and environmental challenges involved in transforming potential resources into realities, and the importance of market forces and institutional mechanisms in making our global system work.

I think we are entering a new age of reality concerning science and technology — about what they can and cannot be expected to do, in what time frame, at what costs, and with what social and cultural implications. Our frame of reference has expanded many fold so that today we assess technologies to their second and third orders of effects — economic, environmental, and social — and we often attempt this even before we know if they will work. This process has come to involve considerable controversy, some of which I will touch on later.

There is just one more point I should make in this litany on complexity before turning to specific issues. It is that the actual relationship between our ideas about science and technology have become more sophisticated. We know that technology historically predated science as we conceive of it today. In recent years, because of the great surge of successes in basic sciences — nuclear physics, polymer chemistry, molecular biology, and solid-state research, for examples — all of which have led into technologies of great economic value, we have come to see a linear relationship between basic research, applied science, and development. While much emphasis should be placed on basic research to increase the knowledge capital we need for innovation, we recognize more clearly now that basic research and applied science drive each other. As new technologies are devised and operate on the basis of the current state of the art, they make us aware of gaps in and needs for knowledge. They reveal inherent shortcomings that demand material and design improvement, and they create subsidiary problems which call for further scientific research. At the same time advances in basic research — some made possible only through the help of new instrumentation — enable us to discover hitherto unsuspected problems with a technology or its effects.

Since technological innovation has become a major force in advancing our economy, and since scientific research has given us the means to analyze with increasing precision the state of our environment and our health, many major science and technology policy issues involve conflicts between the two. In some respects they are both handmaidens and adversaries.

Such science and technology policy issues are particularly painful — and political. They emphasize that cost, benefits, and risks are not equally distributed throughout society. They also involve us in some essentially Faustian bargains in which we commit ourselves to technologies that offer substantial gains but bind future generations to long-term obligations, such as the surveillance of nuclear waste. There are also situations where we must make a judgement, and possibly a commitment, on the basis of incomplete or inconclusive knowledge. These decisions may not be irreversible, but they involve such large commitments of resources — money, manpower, and facilities — that to drop them and change course appears economically catastrophic.

Yet we must go on making these kinds of judgments. The dynamics of our economy, the pressures of population and social expectations, and the maintenance of our position and influence among the other nations of the world demand it.

With all this as background, let me turn to some of the issues which we face in the Office of Science and Technology Policy and the type of guidance the President looks for from me as his adviser and Director of O.S.T.P.

**An Epidemiologic Transition**

In terms of the dynamism which I have discussed, perhaps it is best to start with the areas of the life sciences — particularly the biomedical and health fields; for it is our im-

proved fertility, decreased mortality, increasing life span, and subsequent larger population that underlie most of the other issues.

Begin with the issue of health itself. In the advanced nations the success of vaccines, antibiotics, and broad public health measures has reduced the mortality of the young and is increasing average life span remarkably. This, plus other factors, has resulted in what is known as an epidemiologic transition. Simply put, it means that the major causes of deaths in the population have changed from the bacterial epidemic and endemic diseases to the degenerative and so-called man-made diseases — from pneumonia, typhoid, cholera, diphtheria, influenza, and tuberculosis to cancer, cardio-vascular disease, and diabetes. We call these man-made diseases because the changes and stresses of our new life-styles — our eating, working, and general living patterns — are largely responsible for them.

Various issues of science and technology policy that our Office has been tracking and on which we've been working spring from this situation. We are broadly interested in the whole pattern of health research with the motivating idea being this: the cost of health care and medical technology in the U.S. has increased tremendously, posing some major economic and social problems. Some believe that we have become "over-medicalized" — that is, too dependent on medical technology and drugs — saying that we should instead emphasize such things as better preventive medicine, public health measures, health education, and nutrition. The last item — particularly the scope and organization of nutrition research — is one we are reviewing in some depth. For all the popular interest in foods and the importance of nutrition — diet, vitamins, "organic" foods, and so forth — human nutrition research is an underdeveloped area of the biomedical sciences; we have devoted more effort to animal nutrition than to human nutrition, and we know more about it. As a result there is a lack of scientific knowledge relating nutrition and health; yet we know that nutrition has a direct bearing on many health problems, including heart disease, diabetes, hypertension, and obesity.

Cancer is another health issue of great importance in our epidemiologic transition, another example of a technology-driven situation. For there is evidence that between 60 and 90 per cent of human cancer is environmentally caused, much of it the result of technologies that produce and release toxic and carcinogenic substances. As Donald Kennedy, Commissioner of the Food and Drug Administration, has pointed out, our productive chemical technology is each year turning out about 1,000 new substances that eventually find their way into new products and out into the environment.

We have recognized the risk inherent in this situation and have passed toxic substance legislation to control it. But legislation cannot control anything until it is implemented, and we are finding that new substances can be developed more easily than their environmental and health effects can be evaluated; the latter takes time, facilities, manpower, and money — and not necessarily in that order. As Dr. Kennedy has said, "The presently-developed testing capacity in the private sector is adequate to perform about 800 long-term carcinogenicity studies at any given time. If you add the major public-sector laboratories and assume they do only routine testing on new chemical entities, you would have a capacity of perhaps 50 to 100 studies at any given time." On this basis, he concludes, "Not only is there a backlog; we are losing ground."

**"(Toxic substance) legislation cannot control anything until it is implemented, and we are finding that new substances can be developed more easily than their environmental and health effects can be evaluated. . . ."**

There are other difficult problems associated with this matter, including the quality of the testing and the economic implications, to which I'll return in a slightly different context later.

### Safeguarding Mankind from Himself

Environmental issues have many manifestations with which we in science and technology policy must deal. Some are man-made issues, again driven by our previous and current advances. Some are generated by forces beyond our control; we should not be blamed for all our problems.

Consider, for an example in the man-made category, the issue of dam safety. There are some 50,000 dams in the U.S., only a small number of which are federally owned. These dams range from huge hydroelectric projects through irrigation, flood control, and reservoir facilities of many sizes to the smallest of local impoundment and abandoned hydropower systems. While most have proved safe, there have in recent years been a number of incidents of failures, some involving considerable loss of life and property. Accordingly, at the President's direction we have organized a thorough review of dam safety that may result in recommendations for necessary government action.

As we all know, our efforts to expand and develop new energy sources have generated major environmental and safety concerns. These are the responsibility of various federal agencies, and we are tracking some of them at the White House level. The speed and effectiveness with which these concerns are resolved will bear on what energy alternatives we can move ahead with most productively and confidently. Among the important issues are the management of radioactive waste, the health effects of increased coal use, and the global build-up of carbon dioxide in the atmosphere.

Some environmental and safety problems can be resolved principally by improved technology at an in-

**"The question of how we stimulate innovation may be the most important question of all. . . . Must it always take a major threat to our society, some form of catastrophy or dislocation, to stimulate us to growth?"**

creased cost. To resolve the health effects of increased coal use, for example, we can develop and implement a number of changes involving improved mine safety, better strip mine reclamation, and efficient coal desulfurization. As energy consumers, we must eventually pay for such required technological improvements in the form of increased costs of power and of manufactured products, and in most cases such costs can be fairly well distributed. But in some cases, although the technology can be greatly improved to assure safety, there are residual problems when it comes to distributing risks, costs, and benefits.

Consider, for another example, the problem of storing high-level nuclear waste. Even though the technology for managing such material may be greatly improved, the waste will have to end up somewhere: some state, some locality, some group of people must ultimately accept it with some degree of confidence in the technology and safeguards provided. This, then, becomes a matter of public policy beyond the realm of science and technology.

The matter of increased atmospheric carbon dioxide has even greater ramifications. Here we are dealing with the need for increased scientific knowledge to learn with greater accuracy how much carbon dioxide will actually accumulate in the atmosphere due to fossil fuel combustion and how much it will raise average global temperatures. We need to explore the implications of that temperature rise on our weather and climate and through it on agriculture, recreation, and many other aspects of life. Such considerations must ultimately be international in scope, for $CO_2$ knows no national boundaries. And studies on the same general problem must include the fullest possible evaluation of alternative energy sources, against the possibility that we will find it necessary to phase out the burning of hydrocarbons. This could hasten the shift to solar and nuclear energy and possibly stimulate research toward fusion. To some extent, these concerns have emerged because of our increasing dependence on oil and our declining domestic oil production. But the emphasis on pursuing more energy alternatives could be increased.

Changes in energy supply and cost and in environmental science and technology have had major effects on the state of agriculture, and the impact of future changes will be greater. Over the years we have developed an agricultural system highly dependent on relatively low-cost energy, abundantly available water, and fairly dependable weather. All these factors seem to be in doubt in the next 100 years. One result is that vast new efforts will have to go into agricultural research and development, in our own country and around the world. New systems of fertilization and irrigation are already being pursued, as well as new methods of cultivation, harvesting, and processing that are less energy-intensive and more conserving of our soil. There is great interest in developing new genetic strains of crop plants that will fix nitrogen, be more efficient in their photosynthesis and use of carbon dioxide, resist diseases and pests, and be adaptable to climatic changes. We have to develop and bank a great variety of such strains to be prepared for all sorts of future contingencies.

There is also a great interest today in developing plants — for food, fiber, and fuel — that can be cultivated in areas where agricultural activity has heretofore been very limited or impossible, particularly arid areas and some of the humid tropics. This is a matter of particular importance to the developing countries of the world, many of which lie in the desert or wet tropics. And it is especially important to us in the advanced nations because, while we currently have surpluses of food to help make up for shortages abroad, the day is rapidly approaching when the developing countries will seek to be less dependent on food handouts from others. In the interest of world peace, national security, economic stability, and humanitarianism, it is essential that we work with the less-developed countries in this direction — and we are doing so.

Earthquakes are among a number of environmental changes for which mankind is not responsible but whose impact on human life can be reduced by advances in science and technology. This form of natural disaster has historically taken a huge human toll, but we can now foresee mitigating their effects as our science and technology are close to providing means of locating the sites and forecasting the time of earthquakes with some accuracy. The measures to reduce the impact of earthquakes will include designing and building structures to withstand considerable seismic activity in areas where earthquakes are likely, arranging for early warning and orderly evacuation of an area on the basis of earthquake predictions, methods of reducing the damaging energy release in earthquakes, and preparations for social and economic problems in an earthquake's aftermath. My office has been very actively working on these problems through an internal task force comprised of experts from the federal agencies and an advisory panel of outside professionals. We have also tracked the current legislation on this subject, and I believe that much can and will be done in this important area of natural hazard mitigation.

In these and many other ways, there are still a good many things that science and technology can do to improve the human condition.

### From Petrochemicals to Carbohydrates

No discussion of science and technology policy would be complete without covering the important topic of the relationship of research and development to economic growth — to innovation, employment, and the contro-

versial role of regulation as it affects these.

We know that science and technology have been among the principal forces responsible for this country's economic growth. As Professor John Kendrick of George Washington University has pointed out, rising productivity has accounted for about half of the economic growth of the U.S. over the past century, and 40 to 70 per cent of that productivity is estimated to have been generated by technology.

One of the reasons for economic growth and strength in the U.S. is the richness of our natural resources. One of technology's roles in increasing the availability of those resources has been to create resources out of previously worthless matter — to economically exploit increasingly lower grade ores and to develop new materials of great economic value. Through polymer chemistry and solid-state physics we have over a relatively short time created industries and institutions based on some of the most abundant materials on earth.

I believe we are now beginning an era of new growth based on advances in the biological sciences. These will allow us to use the tremendous capacity of microbes to produce and transform substances. Such advances, coupled with many other innovations using bioconversion processes, will allow us to move from an economy based largely on petrochemicals to one based principally on the use of carbohydrates generated by solar energy. We are seeing the beginning of this movement in today's advances in microbiology, enzymology, molecular biology and recombinant DNA, and in the intriguing work going on around the world in bioconversion, which has special significance in developing areas. Such a transition from petrochemicals to carbohydrates will also have definite environmental advantages, as it will be producing mainly biodegradable materials by processes that are essentially nonpolluting.

How can we achieve this and other kinds of advanced innovation? What direction should it take? And why do we need it? Let me attempt to answer these questions by raising a few more.

Could it be that in many respects the economic problems of our time are due to the fact that we are on an inventive plateau? And could that in part explain why we have a situation in which several nations are competing to sell each other the same or similar products — automobiles, steel, television sets, shoes, and many more? May it also be a reason why so many countries are facing continuing high unemployment — because few new industries and social innovations are being created which can absorb trained and untrained youth?

We badly need some new directions, and science and technology could play a role in providing them. The question of how we stimulate innovation may be the most important question of all. In the past, many of our major advances came as the result of wartime necessity or in reaction to some tragic event, a great earthquake or epidemic of disease. But must it always take a major threat to our security, some form of catastrophe or dislocation, to stimulate us to growth?

Many see the free market as the principal stimulus to growth. But is the promise of unrestricted profit the major incentive for worthwhile invention and innovation? Some claim we have become over-regulated and too risk-conscious to come up with truly new ideas, products, and technologies. Others say are we right in moving slowly and cautiously when we find that we have made serious mistakes in advancing ahead in some areas of knowledge. In short, where are our new research and development frontiers, and how boldly or cautiously should we approach them?

I have already mentioned some of the frontiers of greatest importance — the biosciences, health care, protection from natural catastrophes, security from the ill effects of new products of man's technology, and new ways of using natural resources.

Another new direction lies in an area which we entered with some enthusiasm only to fall back with some disenchantment. That is space. The disenchantment may have resulted from expectations of too much too soon, rather than from any fundamental misunderstanding of the environment of space and the costs and benefits associated with it. (One of the dangers of our mass communications and mass media is that we saturate very easily and become very superficial in our treatment of new ideas.) On the basis of what has been accomplished by space science and technology and the long-range potential of the shuttle, the whole realm of space deserves a very serious second look which I believe will come about.

The oceans represent another area that we have long described as a "new frontier" but have scarcely begun to develop. The current political debates over use of the sea foreshadow future activity there.

We are in the midst of an intriguing debate on the merits of large-scale versus small-scale technology, centralization versus decentralization, and capital-intensive versus labor-intensive development. This is a complex matter, and I am convinced that solutions to our problems will not come from moving wholly in one direction or the other. No group has the wisdom or foresight to plan how whole societies, not to mention all of mankind, can or should advance down any single path of development. Nor are these issues that can or should be dealt with by government alone. As we enter an era influenced greatly by public interests and public pressures, we urgently need an enlightened public — one capable of understanding our complex socio-technological relationship and of realizing what we can and cannot do, able to evaluate technological change in terms of its costs and benefits, its environmental and economic impact, and the social change it may bring. Our success in doing this could determine the degree to which our society controls its own destiny or is the victim of the circumstances it unknowingly creates.

**Frank Press** is a distinguished geophysicist, formerly Head of the Department of Earth and Planetary Sciences at M.I.T., who is now on leave from his chair as Robert R. Shrock Professor of Geophysics at the Institute to serve as President Jimmy Carter's Science Adviser. This article is drawn from the first Robert H. Richards Alumni Lecture, presented at M.I.T. on October 8, 1977.

# The Psychology of Conjuring

James Randi

The deceptions practised by magicians upon their spectators — and by "psychics" upon scientists — often involve misdirection, a ready wit, and no apparatus at all.

With the current wave of interest in the ancient art of conjuring has come a plethora of merchants, in shops and by mail-order, all of them dealing in the paraphernalia associated with such a pursuit. But almost as fast as expensive items like The Divided Lady, The Levitation of Princess Karnak, and The Cabinet of Thebes leave the shops, they are back on sale as second-hand specials. The reason is not difficult to determine.

After all, every youngster with an indulgent parent can invest in the equipment; but few can handle the presentation. It's a little like buying a scalpel and studying the location of the parts of the brain, then announcing that you are a neurosurgeon. Indeed, successful conjuring is a lot like proclaiming yourself a neurosurgeon, for the presentation of conjuring always — though sometimes indirectly — involves the mind.

It is the ability of the human mind to arrive at conclusions with an incomplete set of facts or insufficient sensory data that the magician uses to achieve some of his most potent illusions. Without such a facility, the human organism — in fact any animal — would be unable to function; for every moment, we make assumptions about our surroundings that are based upon flimsy evidence, bolstered by memories of past experience in similar circumstances and by the presumption that the world is pretty much the way it was when last we tested it in this particular way.

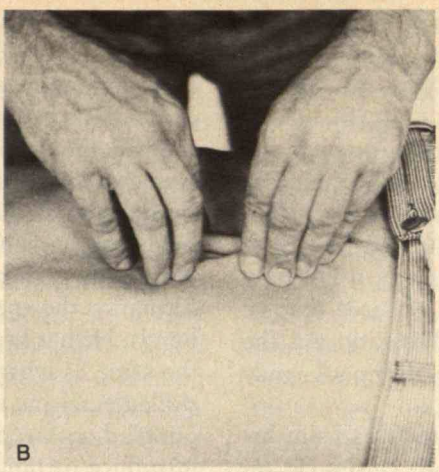
I have as a guest in my home an *anolis,* the American chameleon. He is a simple soul indeed, needing only a small supply of water and a few bugs to keep him well and presumably happy. But because he lacks the sophistication of the higher forms of life, he has been well on his way to perishing on many occasions. In particular, a dead insect, no matter how nutritious and satisfying, fails to attract any attention from this creature. He sometimes walks right over it, and it can be deposited on his very nose without any excitement or hunger being elicited. By contrast, a moving insect, supplying the necessary action and patterns, will bring instant response and ingestion. *Anolis,* then, cannot make the connection between nonkinetic appearance and bug identity; he needs the motion stimulus to complete his information. Needless to say, I find *anolis* a poor spectator for conjuring tricks.

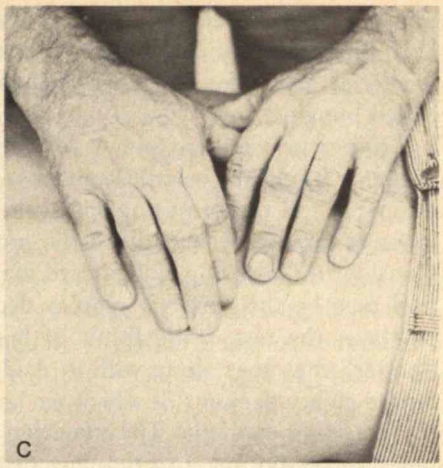
In South America several years ago, I tested my skills on the Shipibo Indians of Peru. They failed to be astonished at such simple magic tricks as a handkerchief that changed color. They were startled, however, when a stone vanished from my grasp by sleight-of-hand. The stone they were aware of as a real and common object; their experience told them that it simply would not do what it had appeared to do in my hand. But the silk handkerchief, for all they knew, might well be a piece of technology. They were amused but not amazed by its metamorphosis. One trick was interesting. The other was possibly supernatural.

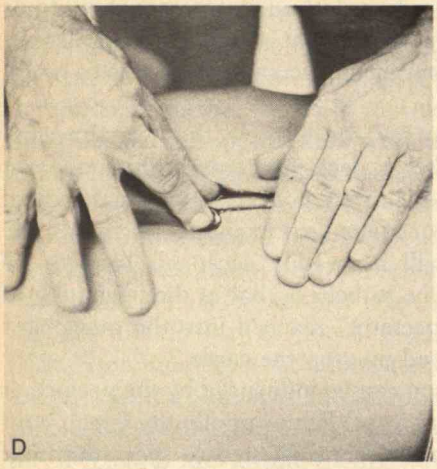
### Minor Puzzle or Major Miracle

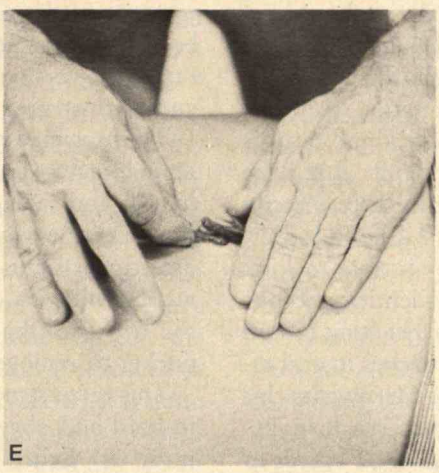
Fully eighty per cent of any good conjuring presentation is the use of psychology. The magician can call it misdirection, showmanship, or just plain skullduggery, but

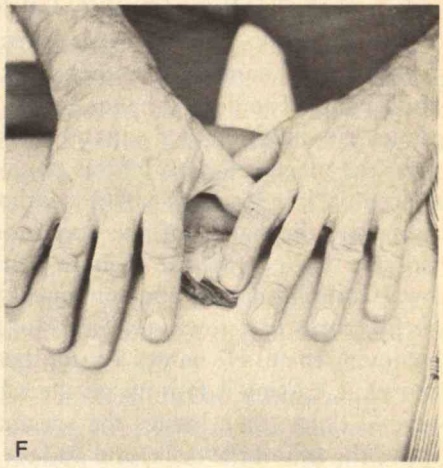

A


B


C


D


E


F


G


H


I


J

The author demonstrates psychic surgery. Photograph *A:* The "surgeon's" hands approach the site of the "operation." *B:* The "patient's" flesh is folded together to form a groove. *C:* The right thumb goes under the left hand. *D:* The right thumb is drawn along the groove and blood is seen to flow. It appears that an incision has been made in the body. *E:* The right thumb and forefinger reach under the left hand and some solid material — the "tumor" — is removed. *F:* The right thumb goes under the left hand. *G:* The right hand picks up the paper towelling and cleans away the blood. *H:* The "tumor" and towelling are bunched together and discarded. *I:* The gimmick (*J* shows a closeup). A false thumb-tip, made of plastic and available from any novelty trick store for about $1.00, has contained the blood and the "tumor." This device is over a century old in the conjuring profession. Now look back at illustration *A.* At this point, the thumb-tip is not easily visible; and indeed, the "surgeon" makes sure that it usually is hidden behind the fingers, not displayed as shown here. In illustration *C*, the thumb-tip is left behind under the left hand as the thumb is withdrawn. In *F,* the now-empty thumb-tip is replaced on the right thumb; and in *G,* it is gotten rid of in the towelling. Photographs: Michael Feirtag.

not every performer can master it enough to be able to both entertain and deceive an audience. Those who do master it are called magicians. Those who do not are called bunglers.

Equipment itself may play a very important part in the trick, or it may be relatively inconsequential. There are even tricks in the conjuring spectrum that use no equipment at all, save the body of the magus and his voice. Consider the case of a skilled card manipulator. His only tool may be the perfectly regular deck of cards that he displays; the rest is the result of his dexterity and the "patter" that goes along with it. And in that patter may be the eighty per cent of which we speak.

Here is an example. The magician produces from his inner jacket pocket a brand-new deck of cards. He removes the cellophane wrapper, breaks the seal, and removes the pack. The end-cards (extra Joker, guarantee) are discarded, and he commences to shuffle the cards thoroughly. The deck is handed to a spectator, who continues the shuffling, then squares up the deck and returns it to the magician, who refuses it, asking only that it be placed back in his inner pocket, without the box, exactly as it left the hands of the spectator. All sounds fair, doesn't it? Yet now the wonder-worker is able to look away from his pocket and announce the identities of four or five cards in a row, *in advance* of his reaching in and removing them! He names a card, then reaches in and removes it, tossing it face-up on the table. He repeats this several times, then invites the spectator to reach in, remove the rest of the deck, and add the "divined" cards to the pack. The whole thing can then be examined freely. The deck proves to be intact, unmarked, and ordinary.

Read back through that description again. Have you a solution? Forget all the complicated laser beams or magnets or UHF receivers that you might like to apply, and think of the simplest possible method.

It's all very easy. The magician has previously opened the pack, removed the four or five cards he wishes to "divine," and replaced the other cards, with seal and wrapping restored. The few selected cards are memorized in order, and placed in the inner *shirt pocket,* adjacent to the inner jacket pocket. The rest is obvious — or is it? Not quite, for such a trick can be either a minor puzzle or a major miracle, depending on the psychology applied.

The spectator must believe certain things without question. First, the deck must be above suspicion. Yet if the pack were given to the victim and *he* were allowed to open it, some impact would be lost, though that sounds illogical at first. The art lies in giving the spectator a minor doubt to entertain and then demolishing it in a casual way. This happens when the magus removes the pack from the inner pocket and opens it himself. The victim accepts, with reservations, what he sees, but has a need to handle the deck. The magician in fact hands it over casually, asking that it be further shuffled ". . . if you wish . . ." This offer is never refused. The casual approach completely disarms the spectator. It now seems as if none of this procedure is really important at all. He has, after all, been given free handling of the cards, and he himself places them into the pocket again. Thus he relaxes. Notice a further point — the deck is returned to the place from which it came! Otherwise, there might be suspicion (and well-founded, too!) concerning the placing of the deck in a side jacket pocket, for example.

Also, the cards are referred to rather carefully: the magician *never* calls the deck "ordinary." To do so would raise the possibility that it might *not* be ordinary. Instead, by de-emphasizing the props, the magician attracts attention to the performance. Recall that at the end of the performance the spectator has a regular deck intact in his hands. He has been led to believe that what he now has is the same as what he originally shuffled so carefully. The skilled magician must now be able to recap the procedure outlined so far, and in so doing falsely though logically introduce or omit data essential to creating an incorrect memory of the procedure. Indeed, spectators should not be able to correctly relate what actually happened, but rather the version that the magician wished them to retain and reconstruct.

The magician may say, for example, that "you have examined and shuffled a deck of cards with your own hands, and replaced it in my pocket." Note that though the spectator was *not* invited to "examine" the cards, the assertion of this will be readily accepted. Ideally, the victim will even come to believe that at the beginning of the trick he (the spectator) reached into the magician's pocket to remove and unwrap the cards.

This reconstruction can be influenced by the performer in bold and obvious ways. For example, the Israeli conjuror Uri Geller has merely suggested to spectators that keys he had "magically" bent would continue to bend, and the spectators have promptly seen metal distorting left and right. A psychologist who consulted me on this nonsense when Geller was still believed to be the "real thing," and not just a trickster, was convinced that nails had curled up before him in a supernatural fashion. "But I saw it bend," he said. I must add that *this* description was of a nail bent by me — not by Uri Geller — and that the psychologist had fully expected trickery.

Yet amazingly enough, the psychologist persists to this day in his belief that other paranormal phenomena, for which he has been offered equally doubtful evidence, nevertheless exist, and that he has correctly perceived them. This persistence is a second stage in the false interpretation of data instigated by a clever performer. Even though the spectator knows that he has seen a trick, he sometimes decides that his belief in such matters and his need for these phenomena in his philosophy requires a rejection of the facts and an acceptance of the irrational!

### A New Level of Deception

Often, the worst "experts" in solving magic tricks are those who know just enough to disarm them. The real pro welcomes such people warmly, knowing that they will apply their thin experience to his methods and come out wanting for an explanation. Here's an excellent example.

One of the old stand-bys in the trade is a children's specialty that involves two flat wooden rabbit-figures, each with a flat tubular cover. To begin with, the magician shows one side of each rabbit by sliding off the cover.

The first is black, the second white. He announces that by simply covering them again, they will change places. Then however, he makes a rather obvious move whereby each is turned 180° as he replaces it on the table. This gives rise to loud cries of dismay and discovery from the youngsters, and as he uncovers the rabbits and shows that they have "changed places" the hue and cry goes up several decibels, since the young audience is thoroughly convinced that they have discovered the secret. After much by-play and more shrieking from the victims, the magus responds to their shouts of "turn them around!" by doing just that, and the sudden silence that results is deafening in itself. For the rabbits now turn out to have different colors on the other sides. But the colors are bright red and green . . .

The point I wish to make is that the pros considered this to be only a children's trick, but I have performed it in front of adult audiences and discovered a new level of deception altogether. For told that the next trick will be one designed for any children who might be present, the adults look on with great patience. This is replaced by discomfort as it begins to appear that the conjuror will be discovered in a simple ruse by the juveniles. The adults have been taken in not only in the same way the children have been, but also at another level, wherein they believe that there is no way for me as a performer to save the trick. Soon, therefore, the adults are doubly astonished at the unexpected outcome. The solution to the trick is quite simple, but the magus has created an atmosphere wherein the spectators are certain of themselves, and are led to relax their critical faculties.

I recall that when I appeared with Barbara Walters on an NBC-TV show some time ago, I had to do a "psychic" key-bending trick under almost impossible circumstances. I fell back on a subterfuge which either works one hundred per cent or fails miserably. I held two keys, one already bent by a so-called psychic performer months before, and a brand-new one that I was challenged to bend. I needed Barbara's attention glued to a certain spot, and to test her mood, I asked her to look at one of the keys. She replied that she was going to watch *this* one, thank you! And that was all I needed to "put in the work" necessary. She had resisted my suggestion, and committed herself to doing just what I wanted.

The same technique was applied when I was stopped late one night in a New Jersey town by a policeman who was known to be over-zealous but not over-bright. I'd had run-ins with this town's police before, and when he stepped to his radio to call the station for advice, it was in my interest to know what was being said. Thus I announced to him that I would stay where I was by my vehicle, which was where he had intended I stay. His prompt reaction was to command that I stand by the police car, which was where *I* had intended I should be. Shades of Brer' Rabbit . . .

### Scraps in a Vase

Early in my pursuit of a conjuring career, I began to wonder about the purported powers of the spiritualists who headed churches in my home town of Toronto, Canada. (Even today, that city must admit that such crackpottery flourishes there.) With a pair of my teenaged friends, I attended a few "services," singing the songs and listening to the claptrap about Summerland ("The Great Beyond") while the medium in charge worked up to his or her great moment of revelation. Though we considered ourselves quite sophisticated in solving such simple subterfuges as we expected to witness, we had a few surprises coming.

We'd been told, for example, to write out something and enclose it in an envelope upon entering the service. Everyone present had done this, in hopes of communications from the grave. Just what the logic of writing out the request was, we were not told, but this is the established procedure, and victims are not encouraged to ask about it. Late in the service, the basket of envelopes was borne up to the front, where the medium presided over the growing excitement. And then the miracles began.

Suffice it to say that there is a simple way of knowing the contents of the envelopes, surely and completely. In this account, however, I will deal with the psychology of the affair. To begin with, we three were puzzled when the medium held up an envelope, and glancing at the face of it, asked who "M.L." was. A hand shot up in the audience (excuse me, I meant to say "congregation"). "Is your first name . . . Marilyn . . .?" the medium asked. Vigorous nodding in affirmation, and soft sighs of wonderment from all around. "The last name is . . . Linn . . . no, but something like that." The medium cupped his hand to his ear, then rubbed his eyes. "The light is very bad here, and I cannot hear the Voices well . . ." The victim quickly called out to him: "It's Lindsay!" And murmurs of satisfaction joined the medium's satisfied nods.

There was a moment of intense concentration, and then the medium threw his hands up in astonishment, eyes wide open and gazing toward the victim. "As I stand here, madam," he said, "I see flashes of bright colors in front of you . . . as if made by a banner on a pole . . . . as if from a flag, perhaps. Is that significant to you?" A puzzled expression from the lady concerned, followed quickly by the medium's adding, "But there are *two* flags! Both of them are red, white and blue!" He warmed to his task. "A Union Jack and a Stars-and-Stripes! As the flag waves one way" (he demonstrated grandly with his hand), "it is a Union Jack. And as it passes back" (more hand swoops), "it becomes an American standard . . . Tell me, are the spirits right who inform me that you are undecided about making a move from Canada to the United States?" Smiling affirmation and great sounds of satisfaction from all around greeted this question and its answer. And there were three very puzzled would-be magicians as well.

We went up front to chat with the medium, who had been tearing up the envelopes with their contents and tossing them into a long-necked vase standing by the podium from which he held forth. I was commissioned to tip the vase over surreptitiously and extract whatever I could. I was lucky, and made off with a handful of scraps. We three left to consider the evidence at a local restaurant over cold root beer, which is known to promote cerebral activity in the teenager.

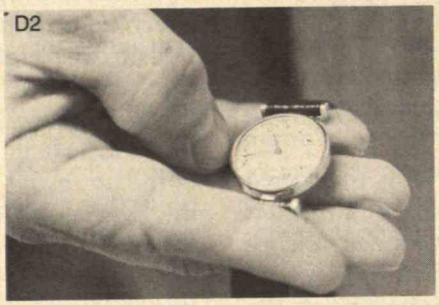
Among the scraps we found the remains of both the en-


A


B

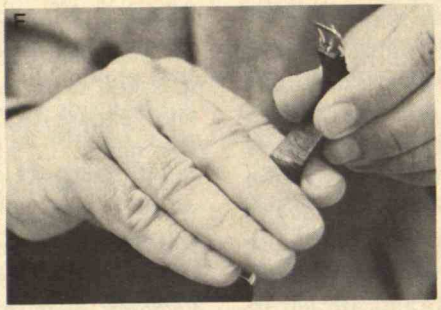

C

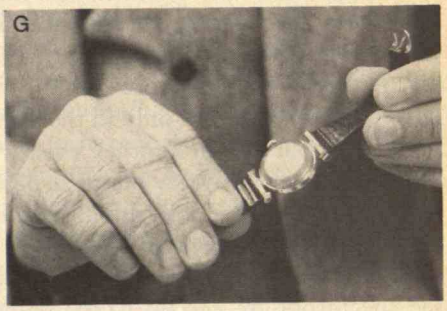

D1


D2


E1


E2


F


G


H1


H2


I


J


K


L


M


N

The Uri Geller watch-trick. Photograph *A:* Performer asks to see the spectator's watch. *B:* He takes it carefully, holding it by the strap. *C:* The watch is held flat in the right hand by two fingers. *D1* and *D2:* The performer establishes "eye contact" with the victim. Meanwhile, his thumb-nail pushes down between the winding-stem and the body of the watch. The stem pops out. *E1* and *E2:* The performer calls attention to the time — 5:14. His thumb covers the popped-out stem. *F:* The performer turns over his hand. His thumb sweeps across the knurled stem, and the time setting is changed. *G:* The watch is revealed — back out. The stem is still pulled out, but the spectator doesn't notice, being unprepared and distracted. *H1* and *H2:* The watch is placed face-down in the spectator's hand. The stem is pushed back at the same time. *I:* The spectator is asked to hold the watch down with a finger while the performer makes an appropriate magic gesture. *J:* The performer picks up the watch — "Only by the strap, as always," he says. *K:* He looks at the watch, disappointed, and declares, "Not yet!" (Notice the exaggerated handling of the watch by the strap tips, now that the "work" has been done.) *L:* He returns it to the spectator's hand "for another try." *M:* Once more, the magic gesture. *N:* At last! The spectator is shown the watch, changed to a different setting by some unknown (?) means. Photographs: Owen Franken.

velope and the contents involved in the episode described above. When we'd entered the "service," we now recalled, we'd been asked to write our names on the outside of the envelope and ask a "detailed question" on the slip provided. When the medium had consulted the outside of *this* envelope, however, we had assumed that only the initials "M.L." were written thereon.

We were wrong: the entire name "Marilyn Lindsay" was there. Things were becoming clear now. The medium had known the entire name, but had declared that the light was bad (since Marilyn Lindsay knew that her entire name was there!) and had ascribed his success to the Voices. Moreover, he had thrown away part of the last name in order to further allay any suspicions that he was merely reading the name. He could easily afford to do this. After all, if he didn't get it all, wasn't that proof that he *couldn't* have read it?

As for the message itself, remember that it was "safely" sealed up in its envelope and that we had been astonished at the imagery he'd gotten. But it was all poetry and great acting, the business with the multicolored banner. For inside the envelope had been a simple question, "Shall we move to Florida?" And from that short query, the medium had developed a complete metaphorical scenario with everything but orchestration and a chorus line. We were impressed.

Note that the medium had also thrown away the "Florida" fact. It removed any suspicion that he had simply read the message — which is just what he *had* done. The medium had even gone so far as to casually ask the lady what state she'd wanted to move to; and he had commented that he had many friends there. What more proof do we need of his sincerity? I must add that the spirits recommended that she think carefully about the move, and make it only if all family matters were settled. A very safe and sufficient answer, indeed.

Another case handled that day was a stunner to us, also, until we examined scraps of the torn-up message. The medium had declared that the subject wished to test the Powers, and upon this being admitted, the medium had flowered to his fullest. "You want me to tell you something only *you* know, and it's sealed within this envelope! Right?" he thundered. A weak "yes" floated up to him. "Your question" — he thumped the envelope — "is . . . umm . . . 'What is my mother's maiden name?' . . . Is that correct?" Another tiny affirmation. "Alright, the Voices tell me I should not dignify this request, but I will do so, for I sense a soul in torment!" He gestured at the air about him, waving his hands wildly. "No, Benjy, I *will* answer this woman! It is my personal decision!" (We discovered later that "Benjy" was a spirit guide not lightly invoked, and fearsome to oppose.)

The drama rushed to its conclusion. There was a clenching of fists, a cupping of ears, and a straining to hear the Voices — all of this the signs of psychic torment. Then came a few gasps and shudders from the audience, and the medium unleashed a smile of victory. "Her name was Robinson!" he announced. "And — she is most definitely in spirit!" A tearful assent from the audience, and the beginnings of an apology for doubting, were

magnanimously cut short by the medium.

The scraps we salvaged solved the miracle. Written on the paper was the statement, "My mother's maiden name was Robinson. Is this a fair test?" We assumed, though we could not confront the woman concerned, that she had asked about a test upon receiving an envelope, and had been instructed to make a simple statement, and append to it a query whether this was a fair test of the Powers. In questioning people in the trade, I have since verified that this is a standard procedure. Please recall that though the question, "What is my mother's maiden name?" was *not* written as such, the essential nature of the test was reflected in the question actually asked. Everyone had assumed, of course, that "What is my mother's maiden name?" was the actual wording used, and we thus had the problem of figuring out how the medium could have known the answer *even if he had had access to the written slip!*

The declaration that the mother concerned was "in spirit" (this is a euphemism for "dead") seemed safe enough. The questioner was at least in her eighties. . . .

A common expression that I often heard in these séance attendances of my youth was the query, "Do you understand?" asked repeatedly by the medium. It followed almost every inane declaration, such as "I see personal conflicts" or "There are others concerned here." The effect on the onlookers is that the inane declarations become highly significant, and part of some unspoken confirmation of truth between medium and victim. Yet consider that the victim can hardly answer "no" to "Do you understand?" for the declarations are easily understood, though not necessarily applicable. The constant affirmative nodding and agreement adds to the apparent success of the reading in the eyes of the onlookers.

**Goal-Switching**

There is probably no better field to investigate, when looking into the psychology of conjuring, than the subdivision of the art known as "mentalism." Into this category fall ESP, precognition, psychokinesis, eyeless vision, and other wonders of the mind. The late Joseph Dunninger was more responsible for turning this field into a performing art than any other person before or since. His use of psychology was perfected to such a degree that it was quite difficult for even those well experienced in conjuring to solve his presentations.

As a youth of 15, I saw Dunninger for the first time in person. He appeared at a theatre in my home town, and I hastened to catch him at a matinee. When the time came for volunteers to mount the stage, I was first up, and eager to watch the master at close range. Alas! The closer I was, the less I solved. But he really floored me when he approached me on stage to ask my assistance in an "experiment" and suddenly stopped short, asking me in a booming voice if I were "a magician." My heart stopped. Surely he could not have known that this skinny kid was studying the art. None of the magicians in town knew me by sight, and none could have known I would be there at the matinee. Was there something to this business of ESP? I began to wonder.

Years later, when I got to know Dunninger well, I broached the question to him. And though he didn't remember the event, he did admit that his action sounded likely. Then he asked me a question of his own: "What would I [Dunninger] have done if you had answered 'no' to the query?" The answer was obvious. Dunninger would have covered it, and would not have allowed the audience to attach any significance to his failure. He had said, "Excuse me, sir, are you a conjuror? A magician?" I'd answered in the affirmative, and he'd made a "hit." But if I'd said "no," he was prepared to follow up with, "Do you sing, or dance? Recite? Juggle?" Again, no. "I was going to let you do a short number while I took a break for lunch! But I see I'll have to earn a living. Just step over here, young man. . ." And the show would have continued. After all, it was not announced in advance that Dunninger would tell me my calling, nor did he make a statement. He simply asked a question. If the answer was in agreement, score a success. If not in agreement, score a neutral point — in fact, do not score at all!

This technique, in mentalism, is called goal-switching. Here is an example of how it works. One of the most effective statements used by the gypsy fortune-teller (or the "psychic") is: "You are separated from your mother?" intoned as half-question, half-statement. No matter what the answer, it's a hit. For if you are still living with your mother, the gypsy nods approvingly. "Good, good. I was hoping that was the way it is." But if Mom has departed, either to the grave or a remote location, it's an even bigger "hit." In many cases, the mentalist performer uses goal-switching, a ready wit, and good psychology with a minimum of material trickery to accomplish his wonders.

Fresh from having seen Dunninger, this youth visited a local newspaper columnist and was fortunate enough to find him at just the moment when he was casting about for an item with which to regale his readers. That evening, among other miracles reported in his column, was one that read, "First, he placed three cigarettes on my desk and invited me to choose one. 'I will write on a piece of paper the cigarette you will choose before you make your choice.' he said, 'though you have no choice. I already know which one you will choose.' Being a practiced moocher, I reached for the first cigarette, changed my mind, and grabbed the third.

"With a little flourish, he handed me the piece of paper from under the telephone. On it was written: 'You will choose the third cigarette.' "

Now what I have just quoted from the newspaper account is impossible. I could not have performed that trick with certainty, nor can I today. Yet the columnist was not really *lying.* He was just making the story more palatable — and making the trick impossible at the same time, though he didn't realize it. You see, the trick I *did* perform was done with *three small piles of playing cards.* The first pile contained three indifferent cards. The second contained four 3's. The third contained five indifferent cards. The prediction itself read, "You will choose the 3 pile," and was therefore correct for any pile chosen. For if the first pile were selected, I merely needed to count the number of cards without turning them face-up, and refer

to *that* pile as the "3" pile, as opposed to the "4" and "5" piles! If the second pile were selected, the second pile was all 3's and therefore properly referred to as the "3" pile. (The other piles could be swept together, turned over, and shown to contain just 2 × 4 (actually it was 3 + 5) indifferent cards. Finally, if the third pile (count 'em, 1, 2, 3!) were selected, the third pile is obviously and indisputably number "3." On this last, I needed only to mis-read the slip as, "You will choose the *third* pile."

Then why did the columnist mis-report the event? Simply because I suggested to him that people might misconstrue it as being just a card-trick — which is exactly what it was. To the reporter, there was no deception at all in his change of props. Both events were equivalent.

I mention all this because scientists investigating supposedly paranormal events are often prone to omit details about their experiments — such as who was actually present during the demonstration — because they believe that these small details are not important to the outcome. They can be very wrong in that belief. What is unforgiveable, however, is the practice of compounding one's errors by denying them and deliberately mis-reporting conditions and events. Science is not served thus. It seems to me that the reputations of scientists studying the "paranormal" are sometimes saved — or made — through such denials and mis-reportings.

**The Impression of Supernatural Powers**

In the laboratory, where a lot of tax and grant money gets flushed away investigating ESP and such, the investigators, usually from the "hard" sciences, get doses of applied psychology that are far too much for them to handle. Those who perform the feats, in the guise of "sensitives" or "psychics," take care, moreover, to create the impression that they are delicately-tuned creatures, liable to throw tantrums and fits and very adversely affected by "negative vibrations." Since this latter term includes skepticism, careful control, and adherence to established protocol, none of these may be allowed if the experiments are to be successful.

The stage magician has the same advantage, though to a lesser degree. For when volunteers step up onto the stage, they are in a strange new world where they function at the whim of the person who belongs there. The magician is in command, and with experience is able to march the volunteers about freely. Psychologically, he gently bullies them, smiling all the while and appearing to allow great freedom of movement and action. Actually, all is well planned.

I must here make a very firm statement. If, from the foregoing, my reader has concluded that I have any degree of disrespect for my spectators, or that I am deceiving them for solely egotistic purposes, please banish such thoughts. I am, in essence, an actor who plays the part of a magician. I use all the skills of an actor to create the impression that I have supernatural powers, and I mislead the audience in order to create wonder in their minds, and thus entertainment. That I use a considerable degree of applied psychology to achieve my ends is in no way reprehensible. My process is, perhaps, more akin to a seduction than to anything else; but it is a pleasant experience for both parties.

Conjuring has been referred to as the "second oldest profession." That may be true. Like all great callings, it employs many hidden and unsuspected skills in its performance. Now my reader knows a little of what goes into a performance. And as I said, a little expertise is just enough to enable you to come to the wrong conclusion. . .

You now have a little expertise. Lots of luck. . . .

**James Randi** is better known professionally as The Amazing Randi, a conjuror and escape-artist. He is a founding member of the Committee for Scientific Investigation of Claims of the Paranormal (CSICP), and a regular contributor to their journal. He has spoken before numerous organizations and academic groups around the world, including the Royal Institution in London, L'Union Rationaliste in France, and the American Humanist Association in New York. His subject was the attempts of science to rationalize seemingly supernormal events. Randi is currently travelling in Europe on behalf of the CSICP to investigate claimed psychics in France and England. He carries with him his check for $10,000, awardable to any person who can produce one genuine demonstration of a paranormal nature. This offer has been open now for 13 years, with no takers.

# Eight Imperatives for R & D

Lester C. Thurow
Professor of Economics and Management
M.I.T.

We know that modern research and development — both military and civilian — has resulted in a vast accumulation of new information leading to an array of new products and new wealth — faster aircraft, more powerful armaments, new treatments for disease, greater personal power and comfort. . . . the list is almost endless.

Yet we also know that in both military and civilian areas there has been no linear, iron-clad relationship between improvements in large, general outputs like the standard of living and sizeable increases in funding for R & D inputs. While real dollar support for civilian R & D programs has more than tripled since World War II, our real standard of living measured, for example, as gross national product per capita or as output per man-hour, is rising no faster than when we were making a much smaller R & D effort. Even more curious is the fact that we spend more on medical R & D than does any other country in the world and yet rank only 24th — and are falling — in average male life expectancy. Thus, while R & D projects in the medical area have produced a cure for polio and have led to revolutionary prototype techniques of computerized diagnosis, life expectancy — the ultimate output — has not been positively affected. In the military area, a hard lesson was learned in Korea and Vietnam: even huge military R & D inputs failed to produce the desired output — a military victory.

Do these frustrations support an argument for doing away with R & D? Intuition and logic both say not, that to quit learning new things is unacceptable. Indeed, each of us could name several complicating factors that explain the lack of expected output — factors beyond technology that ultimately frustrated the primary goal of the R & D efforts. In Vietnam, for example, many new weapons systems were ineffective because the politics and realities of the conflict did not allow their use.

But it is clear that we need to consider seriously how better to relate R & D to the outputs we expect for our investment, and to consider ways of narrowing the gap between our expectations of R & D and the results we achieve through investments in it.

**Research: Basic, Mission, and Massive**

Traditional ways of categorizing R & D — basic research, applied research, and development — do not really help us understand expenditure allocation. A more useful description would be made on the basis of the functional level of a project, separating basic-capability R & D, mission-oriented R & D, and massive-mobilization efforts, the last-named being the occasional, highly focused, all-out programs such as the Radiation Laboratory, Manhattan Project, and Apollo. Each of these levels would include work in the traditional areas of basic research, applied research, and development.

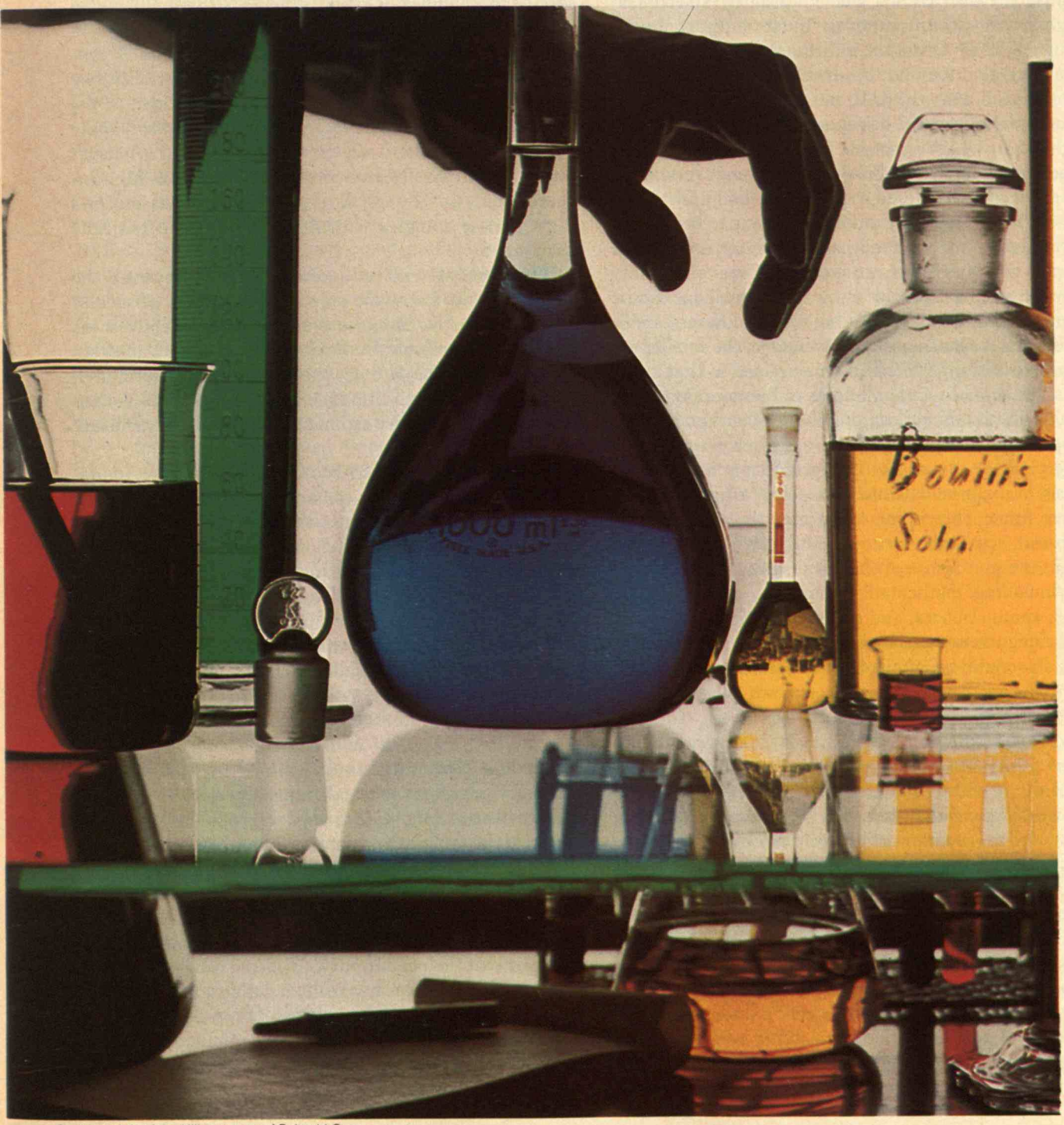
*Basic-capability R & D* programs are proposed to include all those that build up a general fund of knowledge on which programs in mission-oriented and massive-mobilization R & D could draw. Without the support of information and techniques developed in basic-capability programs, neither mission-oriented nor massive-mobilization efforts would be possible.

*Mission-oriented R & D* projects would be structured to achieve stated benefits, and they would include whatever specific breakthroughs in basic knowledge were deemed necessary to realize the benefits sought.

A *massive-mobilization R & D* effort, having the highest priority and cost, would be undertaken only when the benefits were important enough to justify using a significant fraction of the country's resources.

Basic-capability research is not identical with what is now called basic research. Most of today's basic research is actually mission-oriented, funded out of whatever mission-oriented R & D budget is popular enough to stand the financial strain. At one point the Department of Defense R & D budget supported much of our basic-capability effort. Later the burden was shifted to space, and in more recent years — in particular during the early years of the "war on cancer," a project that really should have been the responsibility of the National Science Foundation — it has fallen in large part to the Department of Health, Education and Welfare. Unfortunately, the National Science Foundation never developed the political strength needed to undertake the support of basic-capability R & D as such, in addition to the more easily justified (and funded) mission-oriented projects. To rationalize this illogical but very real situation, we pretend that basic-capability research is mission-oriented research in an area of popular interest. True basic-capability research, such as that being done by the Department of Energy, is not mission-oriented or goal-directed, and is neither wholly military nor wholly

New ways of analyzing R & D could increase the role of science and technology in assuring our security, productivity, and quality of life.




Photograph by John Hill, courtesy of Polaroid Corp.

civilian because both civilian and military progress can draw from its fund of knowledge and skills.

### Nine Fields of Basic Capability

The establishment of rational R & D allocation procedures requires that basic-capability R & D be financed on its own merits, not buried in other budgets. Americans must come to realize the need for truly basic studies — even though apparently unrelated to current problems — and we must find mechanisms to weigh expenditures in areas of research that do not necessarily promise tangible benefits. Funds for mission-oriented research can be readily justified in proportion to expected benefits; but what criteria can be used to weigh support for basic-capability programs whose benefits are largely unknown?

Because no one knows where advances and breakthroughs will occur, funding must support basic-capability R & D across the entire research spectrum — even in areas that may not be currently popular. But this does not mean that the U.S. has to maintain research staffs and plants capable of generating or directing every breakthrough; what we need is the capability to take advantage immediately of breakthroughs in every area. When the Russians learned that the U.S. had built a successful nuclear bomb, they did not take long to build their own. Similarly, after Sputnik, our catch-up time in the space race was very short. To weigh our basic-capability investment, we must consider how fast knowledge can be disseminated and human skills built up in different areas. The greater this speed is, in any given area, the smaller are the resources to be permanently maintained in that area.

Thus, we should survey all areas of human research to determine the minimal level of funding that is necessary to maintain our long-run capabilities in each area. As a starting plan for this survey I suggest that it be made on the basis of eight fields which cut across traditional disciplinary lines. These nine areas are: the life sciences, agricultural sciences, environmental sciences, material sciences, energy sciences, behavioral sciences, logical sciences (including mathematics, statistics, and computer science), space sciences, and equipment sciences.

This categorization scheme is useful for two reasons:

☐ Results could be applied readily to the functional, output-oriented areas in which we are ultimately interested.

☐ Since these categories cut across traditional disciplinary lines, we could more easily make fresh determinations of the resources that are needed in each area. The zero-base planning that is forced on us would be much more likely to generate unprejudiced estimates of the funds necesary to support basic capabilities than would any current categorization, which is likely to produce a defense of the status quo.

### Uncertainty, Risk, and Judgment

If simple theory were practice, expenditures for mission-oriented R & D could be allocated by straightforward application of cost-benefit analysis. First, analysts would apply an appropriate interest rate to proposed R & D funds that reflected potential returns on investment in non-R & D areas, such as stocks and bonds. This interest rate would then be used to discount the proposed R & D funds, providing a control with which to compare R & D investment benefits. Projects with larger discounted benefits than costs would be undertaken; projects with costs greater than discounted benefits would be rejected. Then total expenditures would simply be the summation of economically viable R & D projects, and the total R & D budget would be divided among the various sectors according to the ability of their projects to generate positive net present values.

The procedure is simple. Unfortunately, it is too simple to work in the world of basic-capability research. This is because the fundamental fact of life in basic research is uncertainty. Policy planners and researchers are never sure of the number or types of benefits that will emerge from a given project.

It is important to understand that *uncertainty* is fundamentally different from *risk*. While a risky project may succeed or fail, the policy planner has some idea of the objective probabilities of success or failure and can apply mathematical tools to use expected values (or whatever other measure his loss function would imply) in his cost-benefit analysis. Though the cost-benefit analysis becomes slightly more complex with risk, the process is basically unchanged.

When dealing with an uncertain project, however, the planner cannot know the objective probability of success or failure, and he cannot use mathematics to convert his problem into one suitable for formal cost-benefit analysis. Unfortunately, the R & D process is more uncertain — especially in the area of basic-capability research — than it is risky, so subjective estimates of costs and benefits are often necessary.

Subjective estimates of costs and benefits are fundamentally different from estimates coming from formal cost-benefit analysis because they involve opinions, uncertainty, and a degree of choice. Furthermore, benefits that require subjective evaluation are not readily comparable. For example, what are the relative weights to be assigned to cancer prevention and to national defense? Are lives saved in each activity equally valuable? When analyzing cases like this, policy planners must make value judgments because they have no rigorous analytical techniques. Sometimes dollar estimates are placed on human life using what is called the *value of statistical human life*. This value is determined by observing the monetary premiums that individuals customarily must be paid to accept jobs with a higher probability of being killed on the job, or the premiums that they are willing to pay to lower their probability of being killed in situations where death is possible, as in traffic accidents. However, general moral judgments involved in setting values on life ultimately must come out of the political process.

Because of the need to make difficult value judgments, cost-benefit analysis is not really a good tool for comparing different kinds of basic-capability programs. Cost-benefit analysis may be useful within limited, commensurable sectors — such as the nine research areas suggested above — to determine the programs most likely

to obtain useful objectives within these sectors. But because a proposed program may cover several incommensurable areas, value judgments are often unavoidable. The fact that policymakers use parts of cost-benefit analysis in the budget-setting effort does not alter the judgmental nature of the process. To describe what is going on as an analytical procedure is only to obscure its true subjective nature.

**Cost Ranges, Benefit Ranges, and Maximum Benefits**

One procedure that alone might considerably improve the process of R & D budgeting would be to assign for all mission-oriented projects a *range* of possible (and acceptable) costs and benefits based on determinations by *more than one individual or group*. It is impossible to know the exact cost and the precise benefits of any given R & D project. Setting a single dollar estimate is fundamentally misleading because it masks this uncertainty; at best only ranges of possible costs and benefits can be determined. Given this limitation, neither Congress nor the President should base their decisions on point estimates of either military or civilian project costs.

A calculation of the maximum possible benefit that could be realistically expected is also often a useful tool in such an analysis — for example, the economic benefits of an R & D breakthrough that could double the yield of soybeans. In this case, the probable costs and benefits might not be known with precision but the maximum benefit might be known very accurately.

Applying general measures would enable economists to quantify the ranges of possible costs and benefits and the maximum benefits expected from R & D projects. Such quantification would make the estimates more meaningful — for example, expected *number* of lives saved, expected *number* of lives destroyed, estimated *gallons* of fuel saved, and *dollars* gained.

Once an estimate of maximum benefit is made, the range of estimated costs can be compared with the maximum benefit to see if the project makes economic sense. Obviously, even if calculations promise that the expected maximum benefit will far surpass the range of possible costs, no one can guarantee that the project will be successful. In the real world costs may overrun their expected range and maximum expected benefit may never materialize. Nevertheless, a quantitative guide probably constitutes a good basic, if minimal, criterion.

Maximum benefit calculations can be used to compare similar programs that are competing for funds. Thus, everything else being equal, the R & D effort to cure a disease killing only a few people probably does not merit as much funding as that to cure a disease killing many people. In this way, the value of life is compared with other life, avoiding the problem of converting human lives into dollars. The same comparison scheme works for military programs. It makes good sense to lump together programs that generate commensurate benefits whenever possible, avoiding the sticky conversion of qualitative benefits into dollars, even if subjective judgments ultimately are used to select among programs with noncommensurate benefits.

**Maximizing Commensurability**

For cost-benefit analyses, I suggest splitting the mission-oriented R & D spectrum into four categories:

☐ Research bearing on national independence — defense, space, foreign affairs, and intelligence.

☐ Research whose goal is saving life — programs dealing with health, safety, wartime casualties, and environmental programs designed to save lives.

☐ Research pertaining to economic goods and services, such as energy research and — in some recent manifestations — space utilization.

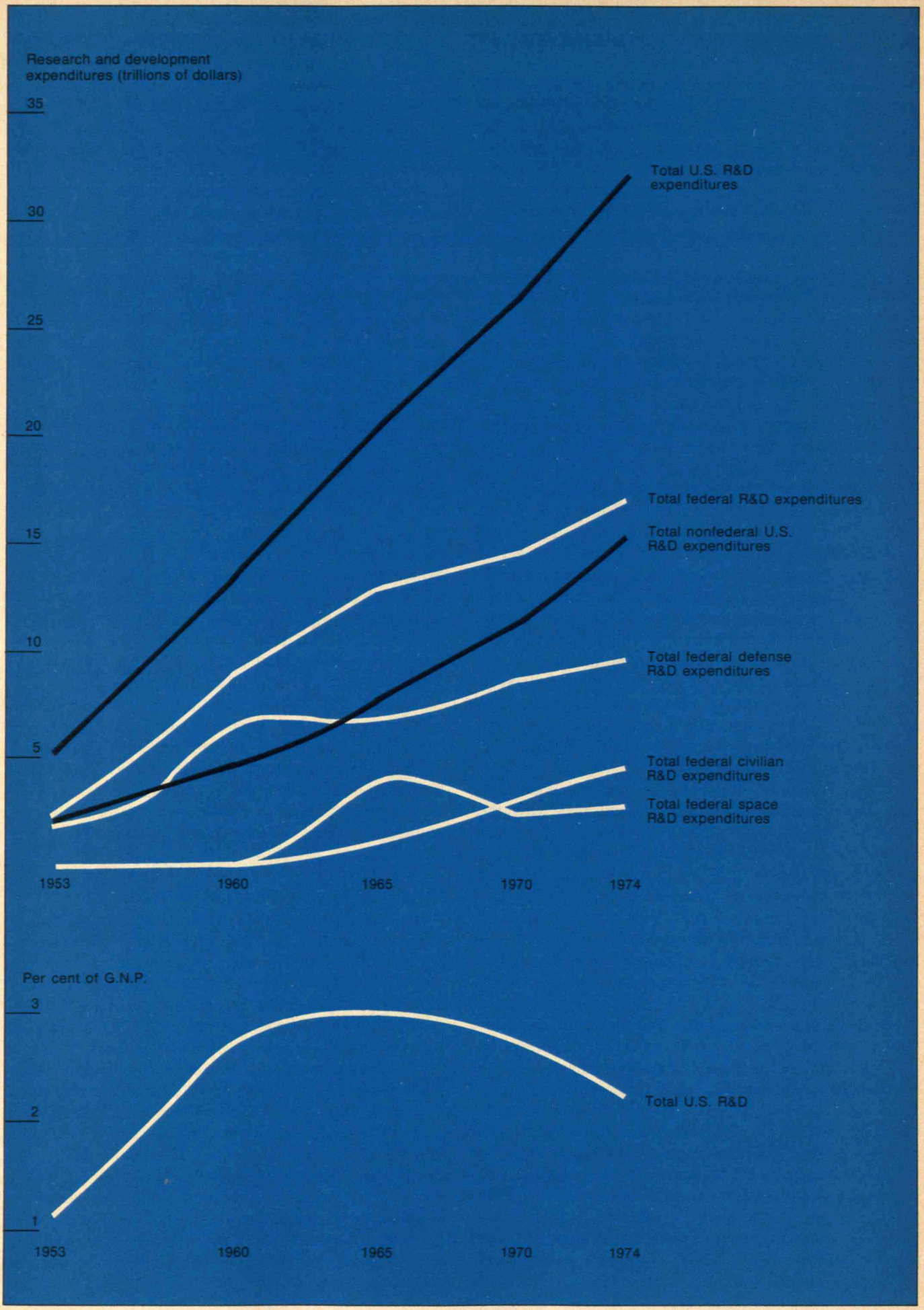
☐ Research on goods and services which bear on the noneconomic "quality of life" — goals such as clean air and water, which are not in themselves marketable.

I propose this four-way breakdown for two major reasons. First, cost-benefit comparisons can be made within each area. Though noncommensurability still exists, it is minimized. For example, the effectiveness of various projects that preserve national independence can be compared one against the other even if it is not possible to compare these programs with life-saving programs, economic programs, or noneconomic "quality of life" programs. Second, benefits in each of the four categories, with the possible exception of the noneconomic goods and services, can be quantified. Policymakers can evaluate life-saving programs in terms of the estimated number of lives to be saved and in economic programs in terms of additional dollars of gross national product generated. Noneconomic "quality of life" goods and services are diverse and thus harder to compare with each other, but even here a few general measures (indices of pollution, social unrest, etc.) might be used for evaluation.

Institutionally, this four-category classification scheme would require that both executive and legislative branches of government reorganize themselves to review the appropriate programs of each category. This would be in marked contrast to present arrangements, where the evaluation of programs is assigned to agencies that administer them and to committees that direct those agencies.

**Massive, Misleading Historical Successes**

Often R & D funds are allocated unproductively because a collection of many hard facts is overwhelmed by the apparently brilliant success of such grand massive-mobilization R & D efforts as the Manhattan Project and various space programs. As stated earlier, such huge undertakings achieved their specific objectives because we were willing to spend enough money and effort to support them. Unfortunately, these successes often lead us toward the erroneous conclusion that all our big problems could be solved if only we somehow came up with supporting funds. But problems are solvable only after they progress from the frontier of scientific knowledge toward the frontier of engineering knowledge. After all, if the basic scientific concepts necessary to formulate a solution are not known, money is of little use. One cannot implement the unknown. To some extent, President Nixon's "war on cancer" fell into this nearly sterile domain, having achieved a level of financial support that was in-


Research and development expenditures (trillions of dollars)
35
30
25
20
15
10
5
Total U.S. R&D expenditures
Total federal R&D expenditures
Total nonfederal U.S. R&D expenditures
Total federal defense R&D expenditures
Total federal civilian R&D expenditures
Total federal space R&D expenditures
1953
1960
1965
1970
1974
Per cent of G.N.P.
3
2
1
Total U.S. R&D
1953
1960
1965
1970
1974

efficiently large. Massive funding made available by the 1971 National Cancer Act has since become a source of support for several basic-capability programs. While no one quarrels with the need to cure cancer, the fact remains that an all-out war on cancer should not have been declared if it could not be won.

How can one tell if there is enough information — basic capabilities — on hand to achieve a major breakthrough in a limited period of time — perhaps ten years at most? Such a determination inescapably relies on opinion and probably bias — those involved with a project provide the data for its analysis and also stand to benefit most from support for their investigations. The only answer is to exercise extreme caution: massive-mobilization R & D should be called for only rarely.

**Spinoffs and Multipliers: Properly Neglected Benefits**

Proponents of R & D — especially military and space research — often make reference to spinoffs — unforeseen advances whose significance lies in their application to a field or fields unrelated to their parent projects. It is important to realize that one never knows in advance if spinoffs will occur, or what their benefits may (or may not) be. Because of this uncertainty, spinoffs are nothing to bank on.

Spinoffs can occur in any kind of research. Knowledge useful to the military is just as likely to be spun off from civilian research as civilian-oriented knowledge is to come from military research. The likelihood of producing spinoffs should not be used as evidence for increasing funds to either military or civilian projects. Hoping that a solution for a known problem will come from some project focused on a different goal makes no sense at all. In the end, a spinoff is a wonderful thing; but it is by definition a fortuitous development, unexpected and therefore unfundable.

From 1953 to 1969 — the end of the Korean War to the middle of the Vietnam conflict — dollar expenditures for research and development in the U.S. rose a phenomenal 500 per cent, a 300-per-cent rise in real spending. The fraction of the gross national product devoted to R & D doubled, jumping from 1.5 to 3 per cent in those years.

Where did all the money go? Much of it went into what Professor Lester C. Thurow calls massive-mobilization R & D. Defense alone grew to absorb 53 per cent of the total effort at the height of the missile gap in 1959, and space consumed 20 per cent of the total in 1965 to provide the basis for the Apollo Project. Meanwhile, civilian expenditures grew steadily, without fanfare, and federal nonmilitary and nonspace projects absorbed budget dollars given up by space research to reach a comfortable 15 per cent of the total by the 1970s.

But our investment in military R & D did not bring victory in Vietnam, and our other R & D investments did not yield a rising rate of productivity in American industry or a discontinuity in the nation's growth rate as measured by U.S. gross national product. It is this unresponsiveness which prompts Professor Thurow's suggestion for new ways of evaluating and apportioning R & D investments.

Just as the benefits of spinoffs should be ignored in allocating research funds, so should the benefits of economic multipliers. All exogenous increases in expenditures are multiplied in the economy when they become income for people who then spend the income. The second round of expenditures leads to a second round of income increase and then to further rounds of rising expenditures and incomes. While the effects of any expenditure are multiplied through this process, multipliers and multiplied benefits should not be used to determine the size or allocation of R & D budgets, either civilian or military.

Since all expenditures in research and development projects produce approximately the same multiplier effect per dollar, multipliers do not help differentiate military from civilian projects. No R & D project can be justified by reason of producing a multiplier effect, and for a very simple reason. If all that one wants to do is create a multiplier effect, there is a superior way to accomplish this end that does not require the sacrifice of real resources — a tax cut.

Let me repeat this fundamental principle: proposals for funding R & D programs must be evaluated on the basis of R & D benefits expected directly from those programs.

**Putting New Ideas Into Action**

A number of constraints other than financing may limit the benefit available from any specific R & D project or program. Institutional constraints that emanate from long-standing habits often prevent advances in knowledge from being put to use. Resistance to the adoption of new products and techniques is probably equally as common in civilian traditions as in military ones. The R & D planner constantly wrestles with the vexing problem of knowing which constraints are flexible and which are immutable. Obviously, allocating R & D funds to areas with crippling constraints is waste of resources.

Some planners, concerned with the failure of R & D to generate more results, advocate reduced basic-capability research efforts and more applied (mission-oriented) development. This reaction is a fundamental misdiagnosis of the nature of the problem. We do not have knowledge that lacks development. Rather, we have an embarrassment of developments that cannot be put in practice because of various institutional obstacles. The way to increase output is to reform the process by which applied knowledge is brought into actual use.

Changes due to R & D may be applicable at any stage between the conception of a product or system and the achievement of an optimal production technique. R & D planners should note that constraints on the utilization of R & D results increase as one moves along an imaginary line drawn between conception and final production. Established production techniques cannot easily be changed or abandoned. Production lines and factories themselves are meticulously designed to be optimally productive for one particular technique. As a rule, switching to a different technique may mean scrapping plant, equipment, and personnel.

### Jumping the Operational Gap

How does "frontier" knowledge become truly operational? As intriguing as the frontiers are, the real impact of R & D breakthroughs comes when they jump the gap between the frontier of engineering knowledge and the range of operational techniques — when R & D comes on line. This jump occurs very differently in military and civilian sectors.

Nations build needed military products as soon as construction becomes technically possible. This quick jump to operational reality is what gives one nation a technical military edge over another nation. In contrast, civilian products must promise to enhance profitability before prototypes herald the coming of production models. The commercial failure of the nuclear-powered ship *Savannah* is a striking example; nuclear-powered ships have been used in the Navy for decades, but their high operating costs prevent their success in the civilian sector.

R & D planners need to remember that the necessity of making profits imposes a much wider gap between engineering feasibility and operational practice in the civilian sector than in the military.

But when profit is not an issue, the movement of R & D breakthroughs from feasibility to operational reality are virtually identical in military and civilian sectors. For example, new medical products and procedures tend to be put into general use in both military and civilian hospitals once they have proved their efficacy. National defense and medicine share a common strategic goal: the preservation of life. In this case we throw out the profitability constraint and use the new technique or product whenever it is technically possible to do so. The result is the faster utilization of new knowledge in areas where profitability is irrelevant or overruled.

### Problems on the Learning Curve

The "learning curve" presents R & D planners with a dilemma — and an important opportunity. Manufacturing engineers and economists agree that production efficiency increases as an assembly line "warms up" — as production techniques are streamlined and the labor force gains proficiency. Indeed, an important phase of the R & D process occurs during actual production well after feasibility has already been established.

But no one knows how to predict in advance the course of this "learning curve." Short-lived programs, such as those typical of the space sector, do not remain on line long enough to develop learning curves. Some products, like modular housing, may proceed very slowly down their learning curve because manufacturers are uncertain of the post-learning costs and proceed with great caution. In the medical area, where lives are at stake, scientific breakthroughs are often put on line without regard to the possibility of decreasing unit costs.

But in most civilian — and many military — areas, the learning curve adds an unponderable to R & D planning: if a marginally profitable new product never goes on line, potential learning will never occur and a possibly successful product never see the light of day; on the other hand, if the product goes on line and production efficiencies never improve, the manufacturer is stuck with an uncompetitive product . . . and a big R & D bill.

Such costs and risks of developing new products put innovators at a disadvantage with respect to their competitors that may outweigh the promise of success. For the first firm to put an innovation into practice bears alone the risk of failure if costs do not decrease quickly enough with learning, while other firms are in an enviable position: they gain useful knowledge by simply watching the innovator's production progress from the sidelines. This high risk serves as a barrier for individual firms to innovate; risk would not be such a formidable barrier to progress if an entire industry shared the task of innovation.

Serious consideration should be given to federally subsidizing the first production runs of some civilian innovations with the understanding that all cost data would be made public as they were generated. Such subsidies have precedent in the space, medical, and defense sectors, where the government — the principal buyer — routinely disseminates production data.

### Cost-Reduction R & D

In today's era of rapidly rising prices and dwindling capital, cost-reduction R & D has great potential. Such programs have paid off in Japan, for example, yielding great improvements in the efficiency of production practices and great long-run savings. But in both military and civilian R & D establishments in the U.S. there appears to be a substantial bias toward pursuing glamorous new products — a bias that draws R & D support away from the less glamorous job of reducing the costs of making existing products. This bias stems partly from the personal interests of scientists and engineers in both granting agencies and recipient institutions and partly from the difficulty of funding cost-reduction research in an economy within which public and private interests overlap. When government funds are used to finance the development of new products, no one can predict the chief economic beneficiary of a successful result. Policy planners will probably support a promising R & D program as long as the economic winners and losers cannot be clearly identified (even to themselves).

Cost-reduction research, however, clearly identifies potential winners and losers because the research effort itself requires knowing who makes and who buys the product. The net result is government reluctance to get involved in this important research area.

### The Eight R & D Imperatives

In summary, I have suggested eight specific courses of action which would, if undertaken, enhance the productivity of R & D efforts in the U.S.:

☐ R & D undertakings should be analyzed on the basis of three broad categories: basic-capability research, mission-oriented research, and massive-mobilization programs.

☐ Funds for basic-capability R & D should be allocated on the basis of nine cross-disciplinary areas: life sciences, agricultural sciences, environmental sciences, material

sciences, energy sciences, behavioral sciences, logical sciences, space sciences, and equipment sciences. Funds supporting research in basic capabilities should be spent on the basis of supporting enough R & D personnel in each area to be able to expand rapidly when breakthroughs actually occur.

☐ Funds for mission-oriented research should be spent according to a modified cost-benefit analysis, showing for each project clearly stated ranges of possible benefits and costs as well as an estimate of maximum possible benefits. Wherever possible, more than one individual or group should estimate the ranges of costs and benefits. Since it is not possible to make analytical comparisons among noncommensurate objectives, mission-oriented research proposals should be subdivided into four types: national independence, life-saving, economic goods and services, and noneconomic "quality-of-life" goods and services.

☐ Massive mobilization research should be undertaken only very rarely and only after the necessary basic knowledge has been accumulated.

☐ The probability of producing spinoffs and economic multipliers should always be ignored in allocating R & D expenditures.

☐ Planners must take institutional constraints into account when allocating R & D expenditures. There is no sense in spending money to develop faster trains unless you also are going to improve railroad roadbeds.

☐ Some procedure must be developed to overcome initial high unit costs and risks in civilian nonmedical production. A good solution would probably be to extend government expenditures that support civilian R & D projects farther along the development path, with the condition that all production data and processes be made public.

☐ R & D aimed at techniques to reduce production costs is probably being slighted in favor of R & D focusing on developing new products. The problem can probably best be solved by reducing or eliminating exclusive proprietary rights from those who do the cost-reduction research, possibly by widely disseminating progress reports.

**Further Readings**


*"National Patterns of R & D Resources, 1953-1974;* Washington, D.C.: National Science Foundation, 1976.

Marglin, S., *Public Investment Criteria: Benefit-Cost Analysis for Planned Economic Growth;* Cambridge: M.I.T. Press, 1967.

Searle, A. D., "Productivity Changes in Selected Wartime Shipbuilding Programs," *Monthly Labor Review,* Vol. 61, No. 6, December, 1945.

Steiner, P. O., "Public Expenditure Budgeting," *The Economics of Public Finance;* Washington, D.C., Brookings Institution, 1974.

Thurow, L. C., "Research, Technical Progress, and Economic Growth," *Technology Review,* March, 1971.



**Lester C. Thurow** joined the M.I.T. faculty in the Department of Economics and the Sloan School of Management four years after completing his doctorate in economics at Harvard (1964); he had studied earlier at Williams College and Balliol College of Oxford University, where he was a Rhodes Scholar. He is known to Boston television audiences for timely and pungent comments on economic affairs for Channel 2 (public broadcasting) and to economists for scholarly contributions on taxes and other national policy issues. This article is based on a study prepared for the Subcommittee on Priorities and Economy in Government of the Congressional Joint Economic Committee and for the Library of Congress.

# YOU ARE CHALLENGED

## TO PIT YOUR CHESS SKILLS AGAINST THE COMPUTER!


**CHOOSE YOUR LEVEL OF PLAY!**

From Beginner to Advanced to Expert!
3 Levels!

**You enter your move, in seconds the computer analyzes all possible countermoves and makes its' best move.**

The computer will not make any fundamental chess errors. You have as much time to ponder your move as you need. For beginning, average and advanced chess players – the average player's chances of beating the Chess Challenger II range from 24% to 70%. You choose white or dark pieces at the beginning and the computer plays until checkmate or stalemate. The Chess Challenger II is ready to play when you are – day or night – no longer do you need to find a human partner to play chess. You can't lose! Try Chess Challenger II. If you are not satisfied, simply return within 15 days for a complete refund.

Order Toll Free 800-621-8318 – 24 Hours Per Day – 7 Days Per Week
(Illinois Residents Call 800-972-8308)

### SPECIFICATIONS:

12-1/8"x8"x1-1/4"high
100% Solid State
Walnut Wood Housing
Felt Foot Pads
Mylar Polyester film covers playing area and keyboard
U.L. Approved 110 volt A.C.

### SPECIAL FEATURES OF CHESS CHALLENGER II:

- Has an amazing memory that will inform you of the location of each piece at any time during the game.
- Double - move capability for castling and en passant.
- Unique entry permits you to watch the computer play an unopposed game so you may learn basic chess strategy.
- Full set of Staunton design wood chess pieces in maple and walnut finish.
- Choose your level of play! Choose from three levels– average, advanced and expert rated by the United States Chess Federation at 1200, 1400 and 1650 points respectively. Varying levels of play makes it the perfect opponent.
- Special lights indicate when you're in check and when the computer is checkmated.
- Chess Challenger II carries a 90 day limited warranty on parts and labor.

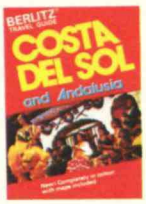


### ACCEPT THE CHALLEGE! ORDER YOURS TODAY!

__ YES, please send ____ Chess Challenger II(s) at $275.00 each plus $8.00 each for shipping and insurance. IF I AM NOT SATISFIED, I may return within 15 days for a complete refund.
__ My check is enclosed. (MN residents add 4% sales tax.)
__ Charge my credit card NO. _____
__ VISA __ Master Charge Exp. date _____

Signature _____
Name _____
Street _____
City _____ State _____ Zip _____

Send to: THE JAYMAR COMPANY, Dept. F-5
919 Julie Drive, St. Cloud, MN 56301


## New BERLITZ Travel Guides

**Choose one FREE when you order a Berlitz Comprehensive Cassette Course**

Take any one of these exciting full-color travel guides FREE when you order your course. Just published, these 128-page guides concentrate on a specific destination, not a country or a continent. Each combines easy reading with fast facts: what to see and do, where to shop, what to eat. Stunning city and regional maps pinpoint sights worth visiting. Sold everywhere at $2.95, one of these colorful new guides is yours FREE with your order. Specify title and number in coupon below.

911 Costa Brava
914 Costa del Sol and Andalusia
915 Costa Dorada and Barcelona
924 Ibiza and Formentera
934 Madrid
935 Majorca and Minorca
947 Rome and the Vatican
956 Venice
908 Corfu
946 Rhodes
960 Crete
918 Dubrovnik and Southern Dalmatia
917 Istria
958 Split
938 Moscow
930 Leningrad
906 Canary Islands

# What would you give to learn a second language? (Try $85.) And what's it worth to your company?

There's a premium being paid for language-knowledge in America today—and it's not only in the export trade. In multinational companies, in major cities, even on the factory floor, a second language marks you as the potential spokesman, the well-educated leader, the man to ask about foreign ways.

And travel is so much more fun when you can meet people and talk their language. Now you can. Easily. Painlessly. All thanks to this 50-lesson do-it-yourself Berlitz® language course. Available in French, German, Italian or Spanish—it's yours for only $85.00.

Packaged solidly in leather-type binding, the Berlitz Comprehensive Cassette Course contains:

1. Ten introductory lessons in a 90-minute long first cassette to familiarize you with the spoken language.
2. Forty additional lessons on five convenient 60-minute cassettes, making a total of 6½ hours of recorded instruction in all.
3. 6 illustrated workbooks to use with the tapes, each containing 50 pages of easy-to-understand, concise information to help you speak with the least difficulty. 300 pages, in all, to get you on the way to fluency in a second language.
4. A specially prepared, easy-to-use Rotary Verb Finder will help you with irregular verb forms—once you're ready for grammar.

This course avoids the dry and the dull—mixes voices, sound effects and useful text in the delightful manner only Berlitz, the world's best known language instructor, can offer. And cassettes don't scratch, don't warp and don't unwind—last almost indefinitely. Best of all, they are easy to stick in your pocket, take along on a trip or use in the car.

Prepare yourself for a rewarding future. At the same time, enjoy the social advantages only a second language can bring. For $85.00, choose the course you need to start talking like a native. Use the coupon and order today.

**MONEY BACK GUARANTEE** Try this Berlitz course for ten days. If you are not satisfied for any reason, simply return it, and obtain a complete refund. You take no risk, so order today.

**For credit card orders dial toll-free, 24 hours a day, 7 days a week**

**800-243-5000**

**(Connecticut Residents Dial 1-800-882-5577)**

Why not give us a ring—right now! (our expense).

**MAIL-PHONE COUPON**

**Berlitz Publications, Inc., Dept. 9044**
**600 Grand Avenue, Ridgefield, N.J. 07657**

**Please print name and address clearly**

YES! Send me your Berlitz Comprehensive Cassette Course today at $85.00 each, plus $2.00 each to cover postage and handling.

☐ French 96100 ☐ German 96101 ☐ Italian 96102 ☐ Spanish 96103

Plus, send me my copy of Travel Guide listed FREE!

Name of Guide_____ No._____

Name_____

Address_____

City_____ State_____ Zip_____

Please indicate method of payment:

☐ Check or money order—payable to Berlitz Publications, Inc.
☐ American Express
☐ BankAmericard ☐ Diners Club ☐ Master Charge

Credit Card No._____

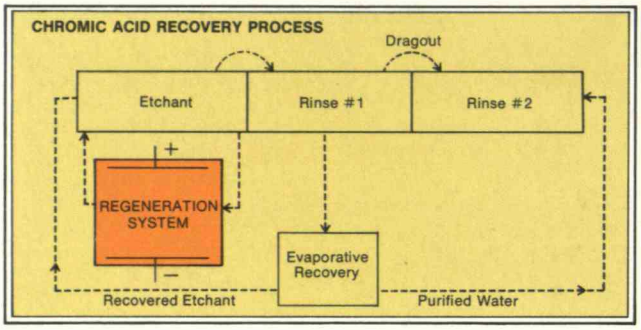
Expiration Date_____

Interbank No. Master Charge Only_____
(Located above your name)

Signature_____

*Allow 4 to 6 weeks for delivery.*
*New York and New Jersey residents add sales tax.*

In industry, chromic acid and oil-water machining emulsions usually live only once. They do their job; then they get discharged, sludged, trucked away, and buried. End of story.




Or is it?

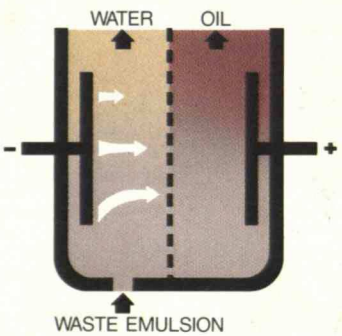
Recently, electrochemists here at the General Motors Research Laboratories have developed ways to infuse new life into these spent materials. In fact, GM's Guide Division is presently using a process of ours to recycle chromic acid.

The acid etches plastic components for plating. However, etching reduces the hexavalent chromium ions to a less effective trivalent form, and eventually the etchant loses its bite. At one time, that meant dumping the bath.

Now, our electrolytic process oxidizes the Cr (III) ions back to Cr (VI). This restores good etching and greatly extends chromic acid life. But first we had to:

- Find an anode material that would favor ion oxidation, rather than oxygen evolution.
- Determine the best anode/cathode ratio and current densities for efficient conversion.

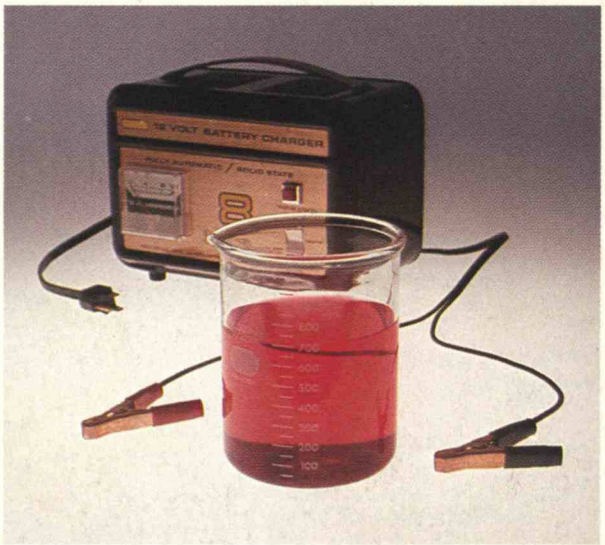
We hope to extend oil life too, in this case by breaking up oil-water emulsions. It's all done in a multicelled electrophoretic unit. Direct current drives oil droplets to the anodes. There the droplets coalesce, and the oil floats to the surface to be collected.




In a successful pilot test, our method reclaimed nearly 90% of the oil without requiring chemicals or forming sludge.

Applying electrochemical technology: Part of the Labs' ongoing program to help conserve critical materials and protect the environment.

# We're recharging and reclaiming "waste" materials.




**General Motors Research Laboratories**
Warren, Michigan 48090